7. WAG 4 ECOLOGICAL RISK ASSESSMENT

The WAG ecological risk assessment (ERA) is the second phase of the INEEL ERA process detailed on Figure 7-1. The results provide a site-by-site evaluation of the potential risks to ecological resources as a result of exposure to radiological and nonradiological contaminants at the WAG-level. The assessment was performed using the results of a previously conducted data gap analysis presented in the WAG 4 RI/FS Work Plan (McCormick et al. 1997) and the basic methodology developed in the *Guidance Manual for Conducting Screening Level Ecological Risk Assessments at the INEL* (VanHorn et al. 1995), subsequently referred to as the Guidance Manual. The data gap analysis was conducted to screen sites identified in the FFA/CO (DOE-ID 1991) and to identify those contaminants present at WAG 4 that have the potential to cause undesirable ecological effects. The sites and contaminants identified as a result of that assessment are analyzed here. The results of this assessment will be integrated with similar assessments for other INEEL WAGs to support the performance of the OU 10-04 baseline ERA.

7.1 Objectives

The objectives of this ERA are to:

- Determine the potential for adverse effects from contaminants on ecological receptors, including protected wildlife species, at the WAG level
- Identify sites and COPCs to be assessed in the OU 10-04 ERA
- Provide input to the data gap analysis for the OU 10-04 ERA.

This ERA was specifically designed to follow the direction provided by the *Framework for Ecological Risk Assessment* (EPA 1992a) and the more recent guidances (EPA 1997 and EPA 1998). This approach divides the ERA process into three steps: problem formulation, analysis, and risk characterization.

The goal of the problem formulation step of the ERA is to investigate the interactions between the stressor characteristics, the ecosystem potentially at risk, and the ecological effects (EPA 1992a). The problem formulation phase results in characterization of stressors (i.e., identification of the contaminants), definition of assessment and measurement endpoints, and the ecological effects that will be used to analyze risk using the CSM. This step of the assessment is presented in Section 7.2, Problem Formulation.

In the analysis step, the likelihood and significance of an adverse reaction from exposure to the stressor(s) were evaluated. The behavior and fate of the COPCs in the terrestrial environment was presented in a general manner since no formal fate and transport modeling was conducted for this WAG ERA. The ecological effects assessment consisted of hazard evaluation, and dose-response assessment. The hazard evaluation involved a comprehensive review of toxicity data for contaminants to identify the nature and severity of toxic properties. Because no dose-based toxicological criteria exist for ecological receptors, it was necessary to develop appropriate toxicity reference values (TRVs) for the contaminants and functional groups at INEEL. A quantitative analysis was used, augmented by qualitative information and professional judgment as necessary. This step of the assessment is presented in Section 7.3, Analysis.

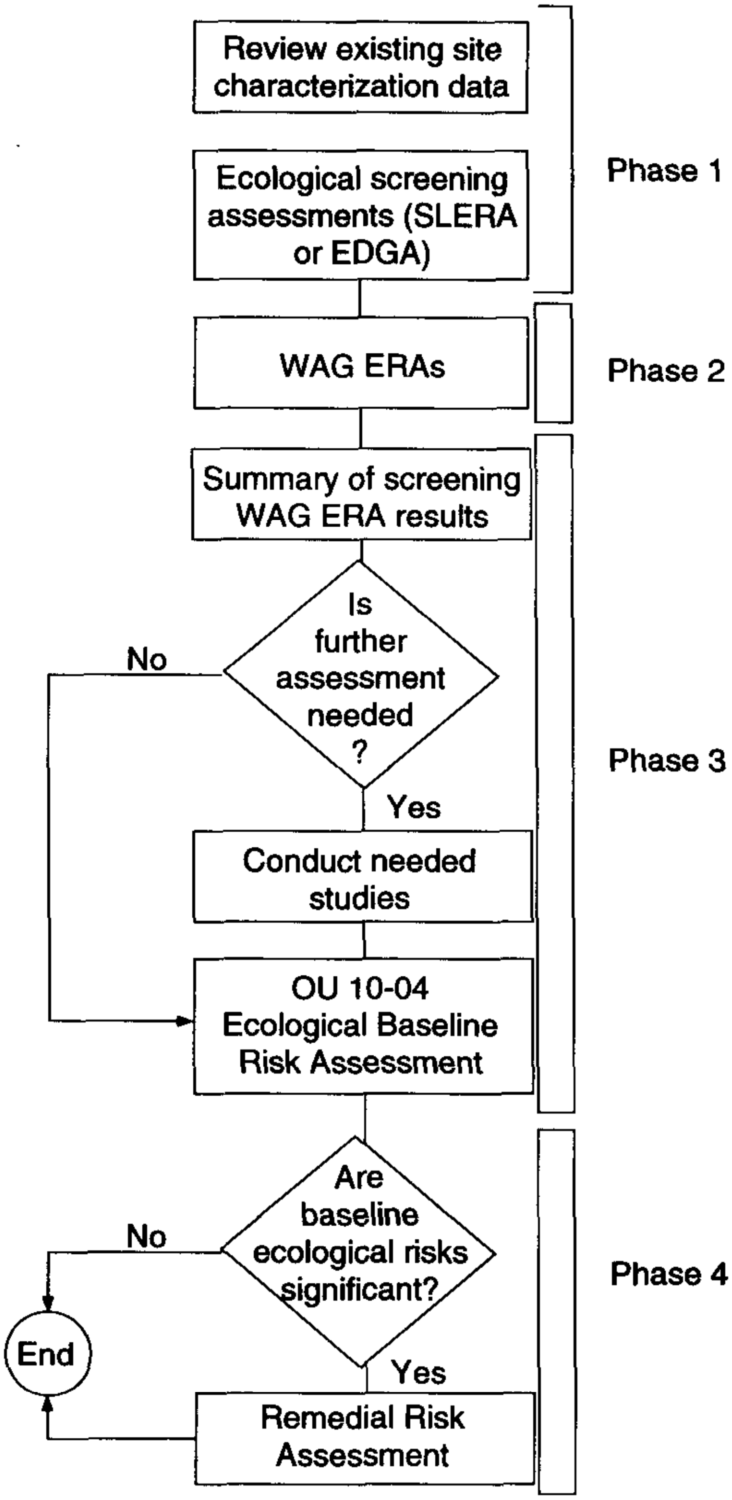

Figure 7-1. A phased approach to OU 10-04 ERA.

The risk characterization step has two primary elements (EPA 1992a). The first element is the development of an indication of the likelihood of adverse effects to ecological receptors. The second element is the presentation of the assessment results in a form that serves as input to the risk management process. To determine whether there is any indication of risk due to the contaminant concentrations, exposure parameters were used to calculate dose to key functional groups and individuals species, including threatened and/or endangered (T/E), and other "species of concern" (see Section 7.2.4.3). Hazard quotients (HQs) were then calculated for WAG 4 receptors by dividing the calculated dose by the TRV and were then used as an indicator of potential effects. This step of assessment is presented in Section 7.4, Risk Characterization.

The results of this WAG ERA will be integrated with assessments for other WAGs to support the Operable Unit (OU) 10-04 ERA. The strategy for using the results of the WAG 4 ERA to support the OU 10-04 ERA is discussed in Section 7.5, Transition to OU 10-04 ERA.

7.1.1 Statutory and Regulatory Basis

The widespread application of ERAs to hazardous waste site investigations under CERCLA began in December 1988, when the EPA directed that "thorough and consistent" ecological assessments should be performed at all Superfund sites (EPA 1988a). This directive was based on the language in CERCLA [as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986 and other statutes] mandating remediation of hazardous waste sites to protect the environment as well as human health. The National Contingency Plan requires that baseline risk assessments characterize the current and potential threats to human health and the environment [40 CFR Part 300.430 (d)(4)], and specifies that environmental risk evaluations "assess threats to the environment, especially sensitive habitats and critical habitats of species protected under the Endangered Species Act" [40 CFR Part 300.430(e)(2)(I)(G)].

Section 121(d)(A) of CERCLA requires that Superfund remedial actions meet Federal and State standards, requirements, criteria, or limitations that "are applicable or relevant and appropriate requirements (ARARs)." ARARs are those substantive environmental protection requirements promulgated under Federal or State laws that, while not legally applicable to the circumstances at the site or facility, address situations sufficiently similar so that their use is well suited to the particular site. ARARs applicable to the WAG 4 ERA are listed in Table 7-1. A further discussion of ARARs is included in the Guidance Manual (VanHorn et al. 1995).

Table 7-1. ARARs for the WAG 4 ERA.

Requirement	Authority	Trigger
Endangered Species Act	16 USC 1531B1543	Location specific
Threatened Fish and Wildlife	50 CFR Part 227	Location specific
Endangered Fish and Wildlife	50 CFR Part 222	Location specific
Migratory Bird Conservation	16 USC 715	Location specific
Migratory Bird Treaty Act	16 USC 703	Location specific
Protection of Bald and Golden Eagles Act	16 USC 668	Location specific
Idaho Fish and Wildlife Act (Preservation of Fishery Resources)	16 USC 756, 757	Location specific
Wetlands Conservation Act	16 USC 4404	Location specific

Recognizing the need, DOE published *Incorporating Ecological Risk Assessment into Remedial Investigation/Feasibility Study Work Plans* (DOE 1994). "This document provides guidance to the U.S. Department of Energy staff and contractor personnel for incorporation of ecological information into environmental remediation planning and decision making at CERCLA sites." (DOE 1994).

Compliance with ARARs is a threshold requirement that a remedial/restoration activity must meet to be eligible for selection as a remedy. ARARs are either chemical-, action-, or location-specific, depending upon whether the requirement is triggered by the presence or emission of a chemical, by a particular action, or by a vulnerable or protected location. A list of the definitions of these ARARs follows.

- Contaminant-specific—Risk-based numerical values or methodologies that establish an acceptable amount of concentration of a contaminant in the ambient environment
- Action-specific—Technology or activity-based requirements for remedial/restoration actions
- Location-specific—Restrictions placed upon the concentration of hazardous substances or the conduct of activity at a given location.

Only location-specific ARARs are applicable in the WAG 4 ERA.

This WAG 4 ERA addresses issues related to all ARARs (listed in Table 7-1) except the Wetlands Conservation Act. This ARAR is included since, wetland habitat at some WAG facilities has appeared on maps as part of the Fish and Wildlife National Wetlands Inventory (Hampton et al. 1995). At WAG facilities, wetland habitats generally include waste ponds that are generated solely due to facility activities and preliminary surveys indicate that most do not meet formal wetland classification criteria (ACOE 1987). However, if future evaluation indicates that these ponds meet formal designation criteria, they will be evaluated based on ARAR considerations. T/E, and/or other species of concern protected by ARARs, are discussed in Section 7.2.4.

7.2 Problem Formulation

The goal of the problem formulation step of the ERA is to investigate the interactions between the stressor characteristics, the ecosystem potentially at risk, and the ecological effects (EPA 1992a). This process begins with a general description of the site (see Section 1 for details) and previous investigations, and a characterization of the ecosystem at risk. Next, the potential stressors to the ecosystem are identified, the migration pathways of the identified stressors are modeled, and the potentially affected components of the ecosystem are identified. The ecosystem at risk and stressor characterization with exposure pathways are then integrated to produce the CSM. The problem formulation step results in characterization of stressors (i.e., identification of the contaminants), definition of assessment endpoints, and the ecological effects that will be used to analyze risk using the CSM. Primary elements of the problem formulation step for the WAG 4 ERA are described in the following sections.

7.2.1 Overview of WAG 4

WAG 4 includes hazardous waste release sites at the CFA. CFA is located in the south-central portion of the INEEL approximately 93 km (50 mi) west of the city of Idaho Falls and northwest of the city of Pocatello (see Figure 1-1). The original facilities at CFA were built in the 1940s and 1950s to house Naval Gunnery Range personnel. The facilities have been modified over the years to fit the changing needs of the INEEL and now provide four major types of functional space: craft, office, service, and laboratory. Approximately 820 people routinely work at CFA.

WAG 4 currently consists of 52 potential release sites divided into 13 OUs. The thirteenth OU is this OU 4-13 Comprehensive WAG 4 RI/FS. The FFA/CO originally included 44 sites in WAG 4. Eight sites were added through the new site identification process. The sites include landfills, spills, ponds, USTs, drywells, and a sewage treatment plant. COPCs include volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), radionuclides, petroleum wastes, heavy metals, PCBs, pesticides, and herbicides. Summary human health assessments, Track 1 and Track 2 investigations, and/or an interim action have been completed for all the potential release sites. See Section 4 for an overview of WAG 4.

7.2.2 Sites of Concern

WAG 4 sites were initially eliminated from consideration in the WAG 4 data gap analysis (DOE/ID-10550 1997) if the site is uncontaminated (no source to the environment) or if the site is inaccessible to ecological receptors of concern (no pathway to ecological receptors). During the ERA, sites identified at WAG 4 were again reviewed for possible elimination from consideration in this ERA for similar reasons. Table 7-2 includes the justification for eliminating sites from consideration.

The list of sites to be further evaluated in the ERA analysis (i.e., the sites of concern) are presented in Table 7-3. This table lists the contaminants identified at each site, and provides a brief description and size of each site. Figure 7-2 illustrates the location of individual sites of potential concern in relation to CFA.

More complete descriptions of the sites of concern for both human and ecological health are presented as part of the human health assessment (see Section 6). Additionally, several sites that have been previously eliminated as a human health risk were assessed for ecological receptors. These sites were eliminated from further consideration under the human health pathway during either the Track 1 or 2 process. The sites typically did not pose a significant risk to human health but did indicate some contamination existed. Since the decision to include or not include sites for the human health risk assessment does not address ecological risks, these sites are retained for assessment here. These sites, which were retained for assessment in the WAG ERA, are described below.

CFA-01—Landfill I is located approximately 0.8 km (0.5 mi) northwest of CFA proper and covers approximately 3.3 ha (8.25 acres). From the early 1950s to 1984 wastes such as construction debris, paper, cafeteria garbage, and other solid and liquid wastes typically found in municipal landfills were disposed in Landfill I. Potentially hazardous wastes were also disposed to the landfill such as paint, resins, sludge, and chemicals. A Track 2 Investigation was performed at this site in 1992. A recommendation was made in the Track 2 to further evaluate the groundwater and air pathways of Landfill I as part of the OU 4-12 RI/FS (Keck et al. 1994).

CFA-02—Landfill II is located northeast of CFA, specifically in the southwest corner of an abandoned gravel pit, and covers approximately 6 ha (15 acres). The gravel pit opened in the early 1950s, and waste disposal began in September 1970 in the southwest corner of the pit. The landfill was used from 1970 until 1982 to dispose of wastes such as construction debris, paper, cafeteria garbage and other solid and liquid wastes typically found in municipal landfills. Although not specifically designated for disposal of liquids, some waste oils, solvents and various chemicals were also disposed to the landfill. After landfill operations ceased, overburden material previously stockpiled during the opening of the pit was used for cover material.

Table 7-2. WAG 4 OU and site descriptions.

OU	Site code	Sites description	Track[a]	In[b]	Justification
4-01	CFA-09	Central Gravel Pit	IA		No evidence of ordnance at the site; no source.
	CFA-11	French Drain (containing 5-in. shell) N. of CFA-633	IA		No evidence of ordnance at the site; no source.
4-02	CFA-13	Dry Well (South of CFA-640)	T1	X	Removal action in 1997; source removed. Confirmation sampling needs to be assessed.
	CFA-14	Two Dry Wells (CFA-665)	T1		No evidence of hazardous constituents disposed at the site; drywells not located; no source.
	CFA-15	Dry Well (CFA-674)	T1	X	Removal action in 1997; source removed. Confirmation sampling needs to be assessed.
	CFA-16	Dry Well (South of CFA-682 Pumphouse)	T1		No evidence of hazardous constituents disposed at the site; no source.
4-03	CFA-18	Fire Department Training Area, Oil Storage Tank	T1		No contamination detected at the site: no source.
	CFA-19	Gasoline Tanks (2) East of CFA-606	T1		No contamination detected at the site: no source.
	CFA-20	Fuel Oil Tank at CFA-609 (CFA-732)	T1		No contamination detected at the site: no source.
	CFA-21	Fuel Tank at Nevada Circle 1 (South by CFA-629)	T1	X	Tank removed in 1991; 5 samples from 7.6 ft contained a maximum of 54,000 mg/kg TPH.
	CFA-22	Fuel Oil Tank at CFA-640	T1/T2		Contaminated soil is present below 3 m (10 ft); no exposure pathway.
	CFA-23	Fuel Oil Tank at CFA-641	T1	X	Tank removed in 1990; 12 samples from 6 ft contained 0.009 ppm toluene & 100 ppm TPH.
	CFA-24	Fuel Tank at Nevada Circle 2 (South by CFA-629)	T1	X	Tank removed in 1991; 6 samples from 7.6 ft contained 26 ppm TPH.
	CFA-25	Fuel Oil Tank at CFA-656 (North side)	T1	X	Tank removed in 1990; samples contained 20 ppm TPH.
	CFA-27	Fuel Oil Tank at CFA-669	T1	X	Tank removed in 1990; samples from 9 ft contained 0.006 ppm toluene, 0.05 ppm ethylbenzene, 0.1 ppm xylenes & 1,100 ppm TPH.
	CFA-28	Fuel Oil Tank at CFA-674 (West)	T1	X	Tank removed in 1992; samples contained 57.4 mg/kg TPH.
	CFA-29	Fuel Oil Tank at CFA-664	T1	X	Tank removed in 1990; samples contained 290 mg/kg TPH.
	CFA-30	Fuel Oil Tank at CFA-665	T1	X	Tank removed in 1989; samples from 9 ft contained 76 mg/kg TPH.
	CFA-31	Waste Oil Tank at CFA-754	T1	X	Tank removed in 1992; samples contained 5,610 mg/kg.
	CFA-32	Fuel Oil Tank at CFA-667 (North)	T1	X	Tank removed in 1990; samples contained 30 mg/kg TPH.
	CFA-33	Fuel Oil Tank at CFA-667 (South)	T1		Tank removed in 1990; no contamination detected at the site; no source.
	CFA-34	Diesel Tank at CFA-674 (South)	T1	X	Tank removed in 1990; 5 samples from 8 ft contained 30–290 mg/kg TPH.
	CFA-35	Sulfuric Acid Tank at CFA-674 (West)	T1		Tank removed in 1989; tank in good condition with no indication of leakage, no source.
	CFA-36	Gasoline Tank at CFA-680	T1		Tank removed in 1990; no contamination detected at the site; no source.
	CFA-37	Diesel Tank at CFA-681 (South)	T1	X	Tank removed in 1990; samples from 9 ft contained 180 mg/kg TPH.
	CFA-38	Fuel Oil Tank at CFA-683	T1	X	Tank removed in 1992; samples contained 427 mg/kg TPH.
	CFA-45[c]	Fuel Oil Tank (CFA-605W)	T1/T2	X	Tank removed in 1991; T1 samples from 19.5 ft contained 0.1 mg/kg benzene, 0.23 toluene, 1.0 mg/kg ethylbenzene, 2.6 mg/kg xylenes and 9,020 mg/kg TPH. During the T2, 2 surface screening samples indicated TPH <40 mg/kg and between 40 and 1,000 mg/kg. No further sampling was performed.
4-04	CFA-39	Drum Dock (CFA-771)	T1		Site used to store gas cylinders; no evidence of release of hazardous constituents; site is currently covered with asphalt. No exposure pathway to ecological receptors.

Table 7-2. (continued).

OU	Site code	Sites description	Track[a]	In[b]	Justification
	CFA-40	Returnable Drum StorageXSouth of CFA-601	T1	X	7 of 9 test kit samples collected in 1995 contained <625 ppm TPH and ~2 mg/kg toluene.
	CFA-41	Excess Drum Storage (South of CFA-674)	T1	X	Samples collected in 1995 contained <625 mg/kg TPH and 2 mg/kg toluene.
4-05	CFA-04	Pond Near CFA-674	T2	X	Site contains a maximum of 362 mg/kg Hg.
	CFA-17/47	Fire Department Training Area, bermed and Fire Station Chemical Disposal[c,d]	T2	X	Removal action in 1997. Contamination from metals was assumed to be removed since PAHs, SVOCs and VOCs did not remain.
	CFA-50	Shallow Well East of CFA-654	T1/T2	X	Well removed in 1994; confirmation samples indicated minor levels of contamination.
4-06	CFA-06	Lead Shop (outside areas)	T2	X	Removal action in 1996. Arsenic and lead remain.
	CFA-43	Lead Storage Area	T2	X	Removal action in 1996; confirmation samples indicated minor levels of contamination.
	CFA-44	Spray Paint Booth Drain (CFA-654)	T2	X	Removal action in 1996; confirmation samples indicated minor levels of contamination.
4-07	CFA-07	French Drain E/S (CFA-633)	T1		Contaminated soil is present below 10 ft; no exposure pathway to ecological receptors.
	CFA-12	Two French Drains (CFA-690)	T2	X	Removal action in 1995; confirmation samples indicated minor levels of contamination.
	CFA-48[d]	Chemical Washout Area South of CFA-633	T2	X	Site partially covered with asphalt; subsurface contamination.
4-08	CFA-08	Sewage Plant (CFA-691), Septic Tank (CFA-716), and Drainfield	T2	X	Contamination remains at this site.
	CFA-49[d]	Hot Laundry Drain Pipe	T2		Contamination remains below 10 ft.
4-09	CFA-10	Transformer Yard Oil Spills	T2	X	Contamination remains at this site.
	CFA-26	CFA-760 Pump Station Fuel Spill	T2	X	Above ground tank removed; contamination remains at this site.
	CFA-42	Tank Farm Pump Station Spills	T2		Removal action in 1997; confirmation samples indicated minor levels of contamination below 10 ft; no exposure pathway to ecological receptors.
	CFA-46[d]	Cafeteria Oil Tank Spill (CFA-721)	T1/T2		Contaminated soil is present below 10 ft; no exposure pathway to ecological receptors.
4-10	CFA-01	Landfill I	T1/RI		See OU 4-12
4-11	CFA-05	Motor Pool Pond	RI	X	No action Record of Decision in 1992.
4-12	CFA-01	Landfill I	RI	X	OU 4-12 Record of Decision in 1995.
	CFA-02	Landfill II	RI	X	OU 4-12 Record of Decision in 1995.
	CFA-03	Landfill III	RI	X	OU 4-12 Record of Decision in 1995.
4-13	CFA-51[d]	Dry Well at north end of CFA-640		X	Well removed in 1996; samples indicate contamination between 1 and 2 ft below grade.
	CFA-52[d]	Diesel Fuel UST (CFA-730) at Bldg. CFA-613 Bunkhouse			Tank removed in 1996; contamination removed to 16 ft below grade and backfilled with clean soil. No pathway to ecological receptors.

a. Stage in CERCLA process as follows: T1 = Track 1; T2 = Track 2; IA= Interim Action; RI = RI/FS.

b. Sites marked with "X" were not screened out of the initial site review.

c. This site was added to the FFA/CO using the new site identification process.

d. A portion of CFA-17 was designated as CFA-47, a terphenyl hot spot. For the 1997 removal action and subsequent sampling, CFA-17 and CFA-47 were treated as one site.

Table 7-3. WAG 4 OUs and sites evaluated in the WAG ERA analysis.

OU	Site Code	Site Description	Area Assessed (m^2)	COPCs[a]	Contaminated Media
4-02	CFA-13	Dry Well (South of CFA-640)	2.50E+01	VOCs, PCBs, PAHs, metals, radionuclides	Subsurface soil
	CFA-15	Dry Well (CFA-674)	3.00E-01	PAHs, metals, radionuclides	Subsurface soil
4-03	CFA-21	Fuel Tank at Nevada Circle 1 (South by CFA-629)	7.00E+00	TPH, BTEX	Subsurface soil
	CFA-23	Fuel Oil Tank at CFA-641	1.11E+01	TPH, BTEX	Subsurface soil
	CFA-24	Fuel Tank at Nevada Circle 2 (South by CFA-629)	2.04E+01	TPH, BTEX	Subsurface soil
	CFA-25	Fuel Oil Tank at CFA-656 (north side)	1.39E+01	TPH, BTEX	Subsurface soil
	CFA-27	Fuel Oil Tank at CFA-669	9.28E+00	TPH, BTEX	Subsurface soil
	CFA-28	Fuel Oil Tank at CFA-674 (West)	8.00E+01	TPH, BTEX, VOCs	Subsurface soil
	CFA-29	Fuel Oil Tank at CFA-664	2.09E+01	TPH, BTEX	Subsurface soil
	CFA-30	Fuel Oil Tank at CFA-665	2.08E+01	TPH, BTEX	Subsurface soil
	CFA-31	Waste Oil Tank at CFA-754	2.52E+01	TPH, BTEX, VOCs	Subsurface soil
	CFA-32	Fuel Oil Tank at CFA-667 (North)	2.08E+01	TPH, BTEX	Subsurface soil
	CFA-34	Diesel Tank at CFA-674 (South)	7.43E+00	TPH, BTEX	Subsurface soil
	CFA-37	Diesel Tank at CFA-681 (South)	5.94E+00	TPH, BTEX	Subsurface soil
	CFA-38	Fuel Oil Tank at CFA-683	7.56E+01	TPH, BTEX	Subsurface soil
	CFA-45	Fuel Oil Tank (CFA-605W)	2.53E+02	TPH, BTEX	No sample data
4-04	CFA-40	Returnable Drum Storage—South of CFA-601	5.84E+02	TPH, BTEX	No sample data
	CFA-41	Excess Drum Storage (South of CFA-674)	5.23E+03	TPH, BTEX	No sample data
4-05	CFA-04	Pond Near CFA-674	6.88E+03	Metals, asbestos, VOCs, SVOCs, radionuclides, PCBs	Surface and subsurface soil
	CFA-17/47	Fire Department Training Area, bermed and Fire Station Chemical Disposal	1.96E+03	VOCs, SVOCs, PCBs	Surface and subsurface soil
	CFA-50	Shallow Well East of CFA-654	2.10E+01	Metals	Surface soil
4-06	CFA-06	Lead Shop (outside areas)	2.50E+03	Metals	Surface soil
	CFA-43	Lead Storage Area	1.53E+04	Metals	Surface soil
	CFA-44	Spray Paint Booth Drain (CFA-654)	9.24E+00	Metals (lead)	Surface soil
4-07	CFA-12	Two French Drains (CFA-690)	1.34E+01	VOCs, SVOCs, PCBs, radionuclides	Subsurface soil
	CFA-48	Chemical Washout Area South of CFA-633	9.29E+00	Metals	Subsurface soil
4-08	CFA-08	Sewage Plant (CFA-691), Septic Tank (CFA-716), and Drainfield	1.85E+04	VOCs, SVOCs, PCBs, metals, radionuclides	Surface and subsurface soil
4-09	CFA-10	Transformer Yard Oil Spills	8.08E+02	Metals, PCBs	Surface soil
	CFA-26	CFA-760 Pump Station Fuel Spill	1.12E+02	VOCs, SVOCs, TPH	Subsurface soil
4-11	CFA-05	CFA Motor Pool Pond	7.43E+03	VOCs, PCBs, metals, radionuclides	Surface and subsurface soil

Table 7-3. (continued).

OU	Site Code	Site Description	Area Assessed (m^2)	COPCs[a]	Contaminated Media
4-12	CFA-01	Landfill I	4.30E+04	Cafeteria waste, construction debris, paint solvents, asbestos, chemicals, misc. wastes	Surface and subsurface soil
	CFA-02	Landfill II	7.07E+05	Cafeteria waste, construction debris, paint solvents, asbestos, chemicals, misc. wastes	Surface and subsurface soil
	CFA-03	Landfill III	8.76E+04	Cafeteria waste, construction debris, paint solvents, asbestos, chemicals, misc. wastes	Surface soil
4-13	CFA-51	Dry Well at north end of CFA-64	1.00E-01	VOCs, metals, radionuclides	Subsurface soil

a. COPC designation as follows: BTEX = benzene, toluene, ethylbenzene, xylene; PCBs = polychlorinated biphenyls; SVOCs = semi-volatile organic compounds; TPH = total petroleum hydrocarbon; VOCs = volatile organic compounds.

CFA-03—Landfill III is located approximately 0.8 km (0.5 mi) northwest of CFA proper and covers approximately 12 acres. After CFA-02 was closed, this landfill was opened (October 1982) to handle the same types of waste disposed in Landfill II and was operational until December 4, 1984. An expansion to Landfill III was opened in 1993 west of the original Landfill III and continued to receive the same types of waste. This area was operational until 1995. The expansion is not considered part of OU 4-12 and was therefore outside the scope of the OU 4-12 RI.

CFA-04—This 6,880 m^2 (76,444 ft^2) site consists of a shallow pond (CFA-674) located southeast of the termination of Nevada Street. Between 1953 and 1965, the site was used for laboratory waste disposal from calcining processes in building CFA-674. Samples collected during 1994, 1995 and 1997 activities were analyzed for inorganic constituents (including metals), organic compounds (including PCBs, VOCs, and SVOCs) and radionuclides. Data indicated that elevated levels of arsenic, barium, cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel, nitrate, silver, vanadium and zinc were present in subsurface soil samples. In subsurface soil samples, the highest VOC detected was toluene (1.0 mg/kg) and Aroclor-1254 was detected at 2.8 mg/kg. All radionuclides were below EBSLs.

CFA-05—The 7,430 m^2 (82,556 ft^2) motor pool pond is an unlined evaporation pond, located in an abandoned borrow pit approximately 3,656 m (12,000 ft) east of the CFA Equipment Yard. The pond received wastes from the wash bay and outside sumps at the Service Station (CFA-664) from 1951 through 1985. The pond continues to collect a limited amount of runoff from spring snowmelt and rain. For the ERA, this site was evaluated as the "ditch" (including the ditch waste pile and drainpipe outlet) and the "pond" (including the main pond, center pond, etc). Data from 1989 indicated that both the "ditch" and "pond" contained high concentrations of metals.

CFA-06—The outside areas of the lead shop consist of a 2,529 m^2 (28,100 ft^2) yard south of Building CFA-674 used for storage of excess materials, including scrap lead and batteries. A removal action in 1996 was conducted to reduce the risk to arsenic and lead. Data from this removal action indicate that arsenic was 14.5 mg/kg and lead was 17.6 in surface soil samples, both which are above EBSLs.

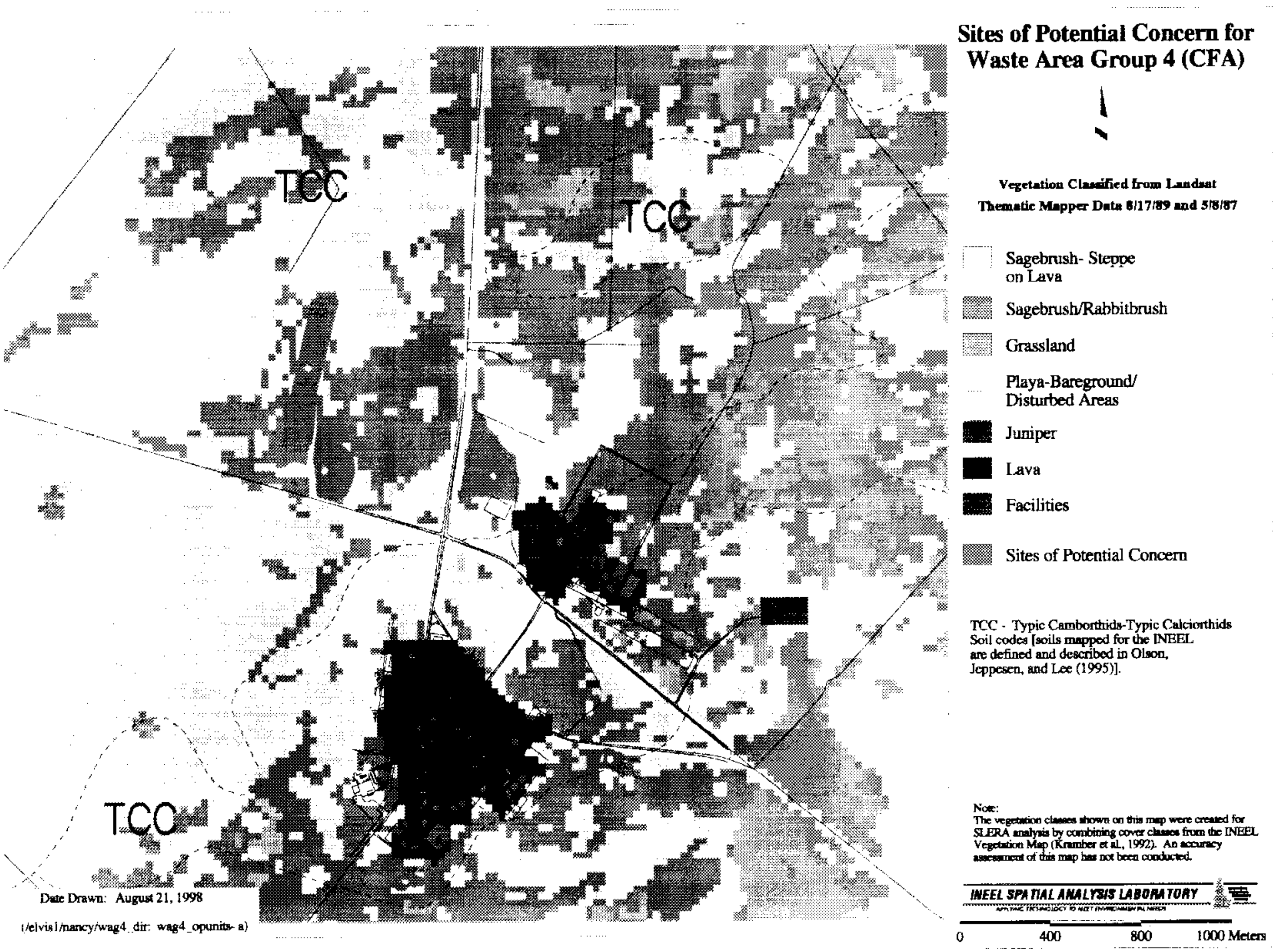

Figure 7-2. Sites of potential concern, vegetation and soil types in the vicinity of WAG 4.

CFA-08—The site consists of the 18,605 m^2 (200,000 ft^2) drainfield for the sewage treatment plant (CFA-691) and the septic tank. The drainfield is located approximately 450 m (1,476 ft) northeast of the STP and originally consisted of five distribution lines. Two of these lines were capped in 1961. Data from the 1994 and 1997 drainfield sampling indicated that elevated levels of metals and radionuclides are present in the soil.

CFA-10—This 808 m^2 (8,978 ft^2) transformer yard oil spill site is located southeast of Building CFA-667. The oil spills resulted from electrical transformer storage and welding shop disposal. PCBs, solvents and metals potentially contaminated the soil at this site. Only elevated levels of metals including antimony, arsenic, cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel and zinc were present in surface soil samples.

CFA-12—This 13.4 m^2 (148.9 ft^2) site consists of two French drains located east of the north corner of Building CFA-690, which housed several laboratories and offices operated by the DOE Radiological and Environmental Sciences Laboratory. The drains were approximately 0.6 m (2 ft) in diameter and extended 1.8 m (6 ft) bgs. Data from investigations in 1995 indicated that the north drain only contained pentachlorophenol. The south drain contained elevated levels of several radionuclides, including Ag-108m, Ba-133, Cs-137, Eu-152, U-235, and U-238.

CFA-13—The 25 m^2 (277.8 ft^2) dry well (determined to be a sump during the 1997 removal action) is located south of the demolished locomotive repair shop Building CFA-640. This building was constructed in 1950 to provide Security and Power Management offices, a physical fitness area, a line crew craft area, an automotive repair garage, and a locomotive repair area. Data from the removal action indicate that subsurface soil (3 to 10 ft) was contaminated with elevated concentrations of PAHs, PCBs, lead and radionuclides.

CFA-15—The site consists of a 0.3 m^2 (3.33 ft^2) dry well located northwest of and adjacent to a laboratory building (CFA-674) at Nevada Street. A floor drain inside Building CFA-674 was connected to the dry well and therefore was potentially contaminated. Samples from the 1997 removal action were analyzed for metals, VOCs, SVOCs, inorganics, herbicides, pesticides, radionuclides, PAHs, and dioxin. Data indicated that only metals and radionuclides were present in subsurface soil (between 2 to 10 ft bgs) at the site. High concentrations of arsenic, barium, chromium III, copper, lead, manganese, mercury, nickel, silver, thallium, vanadium and zinc were detected. Moderate levels of Am-241, Ra-226, Sr-90, U-234, U-235, U-238 and Zn-65 were also detected.

CFA-17/47—The 1,960 m^2 (21,778 ft^2) site consists of the bermed Fire Department Training Area (originally designated CFA-17) and the Fire Station Chemical Disposal, (originally designated CFA-47) located 4 km north of CFA. The sites were combined during the RI/FS because they are adjacent and contain similar wastes. The training area consists of a leach pond and a gravel fire-training pad that was used from 1958 through 1995. The leach pond collected and contained wastes and wastewater from training exercises and consisted of unburned fuel, products of combustion and possible solvent residue. Approximately 18m (59 ft) south of the training area and outside of the berm is where the waxy terphenyls and trinitrotoluene were disposed after training activities. Various metals, SVOCs and VOCs were initially identified but only a few SVOCs and VOCs were detected at elevated levels.

CFA-21—The CFA-21 site consists of a 1,893-L (500-gal) UST near CFA-629 used to store diesel fuel for heating purposes. The former tank, removed in 1991, was located in a grassed area approximately 30.5 m (100 ft) west of CFA-629. During removal operations, the tank was inadvertently punctured resulting in a spill of approximately 284-L (75-gal) of diesel fuel in the excavation. Approximately 227-L (60-gal) of spilled fuel was retrieved and the remaining 56.8-L (15-gal) was adsorbed into the soil, resulting in high concentrations (54,000 mg/kg) of TPH-diesel in soil samples collected in the excavation. BTEX were not detected in any soil samples.

CFA-23—The CFA-23 site consists of one 208-L (55-gal) steel UST adjacent to CFA-641, used to store diesel fuel for heating purposes. The tank was installed in 1949, abandoned in 1975, and removed in 1990. Although there was no apparent evidence of leakage at the removal site, soil samples were collected and analyzed for BTEX and TPH. Benzene, ethylbenzene, and xylene were not detected. Toluene was detected at a concentration less than the risk-based concentration. TPH was detected at a maximum concentration of 100 mg/kg.

CFA-24—The CFA-24 site consists of one 1,893-L (500-gal) UST east of Building CFA-629, used to store diesel fuel for heating purposes. Records indicate that the tank was installed in 1958, abandoned in 1970, and removed in May 1991. The depth of excavation was 2.3 m (7.6 ft). Prior to backfilling the tank excavation area, soil samples were collected and analyzed for BTEX and TPH. Analytical results for TPH showed a maximum concentration of 26 mg/kg and BTEX were not detected.

CFA-25—The CFA-25 site consists of one 1,893-L (500-gal) UST near Building CFA-656, used to store diesel fuel for heating purposes. The tank was installed in 1944, abandoned in 1960, and removed in October 1990. Prior to backfilling the tank excavation area, soil samples were collected and analyzed for BTEX and TPH. The analytical results indicate that BTEX was not detected and that TPH was detected at a maximum concentration of 20 mg/kg.

CFA-27—The CFA-27 site consists of one 55,775-L (15,000-gal) UST used to store diesel fuel for heating Building CFA-669. The tank was installed in 1953, abandoned in 1981, and removed in 1990. Evidence of leakage from the piping was observed during removal operations, and the contaminated soil was removed and treated. There was no evidence of leakage from the tank. Prior to back filling the tank excavation area, soil samples were collected and analyzed for BTEX and TPH. Analytical results from the soil samples indicated a maximum TPH concentration of 1,100 mg/kg. The maximum concentration of 0.001 mg/kg xylene was also detected.

CFA-28—The CFA-28 site consists of a 3,785-L (1,000-gal) UST used to store diesel fuel for heating purposes. The tank was installed in 1956 and used until 1968 when the contents of the tank were removed. The actual tank was removed in September 1992. Soil samples collected from the excavation were analyzed for BTEX, and TPH and using the toxicity characteristic leaching procedure (TCLP) for metals and VOCs. The primary contaminant detected was TPH with a maximum concentration of 57.4 mg/kg. BTEX and VOCs were not detected. Analytical results from the soil samples collected beneath the tank confirm the noncontaminated status of the soil. There is no contamination source at the site because the tank and soil surrounding the tank were removed, and the contaminated soil was replaced with clean fill material.

CFA-29—The CFA-29 site consists of a 3,785-L (1,000-gal) UST adjacent to Building CFA-664. The tank was installed in 1951, and removed in October 1990 after failing the tank tightness test. Laboratory analysis of soil samples collected from the tank bed and analyzed for BTEX and TPH showed a maximum of 290 mg/kg TPH, while BTEX were not detected.

CFA-30—The CFA-30 site consists of a 3,785-L (1,000 gal) UST used for bulk storage of waste oil from CFA-665. The tank was installed in 1951, and removed in September 1989 after failing a tank tightness test. Soil contamination observed in the 2.7 m (9 ft) deep excavation was removed and treated. Laboratory analysis of soil samples collected from the tank bed showed a maximum concentration of 76 mg/kg TPH. BTEX were not detected.

CFA-31—The CFA-31 site consists of a 56,775-L (15,000-gal) UST used for bulk storage of waste oil. The tank was located approximately 2.7 m (9 ft) southeast of CFA-677. The tank was last used in 1985. The former tank, removed in 1990, was located 2.6 m (8.5 ft) south of building CFA-677. The site was 3.6 × 7.0 m (12 × 23 ft) or 25.2 m^2 (276 ft^2). This location was within the CFA-42 area of contamination that was remediated during the 1996 and 1997 removal actions. All contaminated soil was removed from the former tank location. Upon removal, visible areas of contamination were observed in the excavated area. Approximately 260 m^3 (340 yd^3) were removed from the excavation and replaced with clean soil. Analytical results from soil samples collected prior to backfilling the excavation with clean soil, indicated low concentrations of BTEX and a maximum concentration of 5,610 mg/kg TPH.

CFA-32—The CFA-32 site consists of a 681-L (180-gal) UST used to store diesel fuel for heating purposes. The tank is located near CFA-667. The tank and associated piping were removed in October 1990. No evidence of leakage from the tank or piping was observed during removal operations. BTEX were not detected, and TPH was detected at a maximum concentration of 30 mg/kg.

CFA-34—The CFA-34 site consists of a 984-L (260 gal) UST installed adjacent to the southwest corner of Building CFA-674. The tank, assumed to have been abandoned in 1976, was removed in October 1990. Upon excavation, several large holes were observed in the tank along with contaminated soil. The contaminated soil was removed from the excavation and soil samples were collected to determine concentrations of TPH and BTEX. Analytical results indicate a maximum TPH concentration of 290 mg/kg.

CFA-37—The CFA-37 site consists of a 1,893-L (500 gal) UST located on the south side of CFA-681, used to store diesel fuel for heating purposes. The tank was removed in October 1990. Stained soil at the excavation site was removed and treated. Prior to backfilling, soil samples were collected to determine contaminant concentrations. TPH was detected at a maximum concentration of 180 mg/kg. BTEX was not detected.

CFA-38—The CFA-38 site consists of a 1,893-L (500-gal) UST used to store diesel fuel for heating Building CFA-683. The tank was installed in approximately 1949, used until 1980, and removed in May 1992. No evidence of leakage was observed from the tank or associated piping during removal operations. Soil samples collected from the tank bed were analyzed for TPH and BTEX. The maximum TPH concentration detected was 427 mg/kg.

CFA-40—The CFA-40 site consists of a storage area for empty drums awaiting pickup by the product vendor. The site is located south of Building CFA-601. Qualitative screening samples were collected in May 1995 and analyzed for TPH. The results indicated that TPH concentrations were less than 625 mg/kg.

CFA-41—The CFA-41 site consists of an area south of Building CFA-674 which served as a storage area for empty drums prior to resale. The drums are believed to have contained used motor oil, antifreeze, or Stoddard solvent, which were rinsed prior to storage. Qualitative field screening samples were collected in May 1995 and analyzed for TPH. Screening results from two of the soil samples collected exceeded 1,000 mg/kg (the concentration capacity of the test kit). In August 1995, additional soil samples were collected for VOC analysis to further quantify and identify the areas exceeding the TPH action limit. Toluene was the only VOC detected at an estimated concentration of 0.002 mg/kg.

CFA-43—This site consists of a storage yard south of Building CFA-674. From 1940 to 1988, this site was used for storage of excess materials, including scrap lead and batteries. In 1988, a molten lead spill of approximately 4.5 kg (10 lb) occurred along the southwest fenced area, which may have resulted in soil contamination. The spilled lead was allowed to harden, was raked up and recycled. The storage area has been regraded several times since 1988. Following the removal action at OU 4-06 in October 1996, the storage area was covered with a clean layer of packed gravel. The area is currently fenced and contains used office furniture and other stored nonhazardous equipment and supplies for private market sale or disposal.

CFA-44—The site is located adjacent to the former CFA-654 warehouse which is near to center of CFA. CFA-44 is approximately 3×3 m (10×10 ft) or 9.24 m^2 (100 ft^2). This site consists of a drain outlet from a spray booth on the east side of Building CFA-654, where various types of paints such as epoxy, latex, and enamel were used. These materials were used from 1952 to 1983. The spray booth used a water curtain system to scrub paint particles from the air before it was discharged to the atmosphere. Water was recycled through the system and reused in the water curtain. The water was treated using coagulants and flocculants to settle out the solids, which were then collected in a sump and disposed in the CFA Landfill until disposal procedures were changed and the solids were disposed as hazardous waste. Treated wastewater without solids was discharged from the booth to the drain system and then onto the ground approximately once per month. Solvents containing VOCs in the paint booth ventilation air that would have been removed by the water curtain would also have been re-entrained and emitted to the atmosphere.

CFA-45—The CFA-45 site consists of a 45,420-L (12,000-gal) steel UST formerly located southwest of Building CFA-605, and used to store diesel fuel. The tank was removed in 1991. Soil samples collected from the bottom of the excavation [5.9 m (19.5 ft)] were analyzed for TPH and BTEX. A maximum concentration of 9,020 mg/kg TPH was detected. Concentrations of 0.1, 0.23, 1.0 and 2.6 mg/kg were found for benzene, toluene, ethylbenzene, and xylene, respectively. A Track 2 investigation was performed as part of OU 4-09 (Gianotto et al. 1995).

CFA-48—Site CFA-48 was discovered and added to the FFA/CO in 1994 using a new site identification form. The site consists of an area on the southeast side of Building CFA-633 where approximately 11,355 to 18,925-L (3,000 to 5,000-gal) of water containing chemicals was ponded. The laboratory in Building CFA-633 used chemicals including perchlorates and sulfates for dissolution and extraction operations. The site was included in the FFA/CO when an employee gave anecdotal information that radiological contaminants were disposed to the area (apparently before the area was covered with asphalt and concrete). One sample was collected from a spot in the vicinity of the former disposal area after layers of asphalt and concrete were removed. In June 1995, one surface soil sample was collected 2.2 m (7 ft) east of the CFA-633 door in support of the Track 2 investigation. This sample was analyzed for metals, gamma-emitting radionuclides, and anions. For the metals, analytical results indicated that aluminum, lead, and mercury concentrations were detected above background concentrations. For the radionuclides, Cs-137 was detected at a concentration less than background.

CFA-50—CFA-50 was identified as a new site under the FFA/CO in 1994. The site consists of a shallow injection well located along the east side of the former location of Building CFA-654. Building CFA-654 was demolished in 1994; however, the well [approximately 3 m (10 ft) from the building foundation] was left in place. The well is believed to have received paint residues from a paint shop located in Building CFA-654. Soil samples were collected from the well in 1993 and 1994. Metals, VOCs, and several radionuclides were detected. Cs-137 was the only radionuclide detected, although it was detected at a concentration less than background. As a result, the well was removed as part of a time critical removal action in July 1995. Soil samples were collected after the well was removed to obtain adequate data to evaluate the potential risk remaining at the site. Soil samples were analyzed for VOCs and metals. Analytical results indicate that several metals were detected at concentrations slightly above background surface soil concentrations for metals at the INEEL. No VOCs were detected.

CFA-51—CFA-51 is the former location of a small dry well located at the north end of Building CFA-640. The dry well was located at the north end of CFA-640. The dry well and surrounding soil were removed along with the building in 1995/96. The data are from samples collected inside the dry well, which was removed and disposed. Samples were collected from the bottom of the dry well in 1996. Analytical results indicate that Aroclor-1254 is present, and that several metals are present above background concentrations.

7.2.3 Ecosystem Characterization

The INEEL is located in a cool desert ecosystem characterized by shrub-steppe vegetative communities typical of the northern Great Basin and Columbia Plateau region. The surface of the INEEL is relatively flat, with several prominent volcanic buttes and numerous basalt flows that provide important habitat for small and large mammals, reptiles, song and game birds, and some raptors. The shrub-steppe communities are dominated by sagebrush *(Artemisia* spp.) and provide habitat for sagebrush community species such as sage grouse *(Centrocercus urophasianus),* pronghorn *(Antilocapra americana),* and sage sparrows *(Amphispiza belli).* Other communities are comprised of rabbitbrush *(Chrysothamnus* spp.), grasses and forbs, salt desert shrubs *(Atriplex* spp.), and exotic or weed species. Juniper woodlands occur near the buttes and in the northwest portion of the INEEL, these woodlands provide important habitat for raptors and large mammals. Limited riparian communities exist along intermittently flowing waters of the Big Lost River and Birch Creek drainages.

WAG 4, which is comprised of hazardous waste release sites at CFA (see Figure 7-2), is located in the north-central portion of the INEEL (refer to Figure 1-1). CFA is an administrative facility with most land surfaces covered by landscaping, facilities and pavement with areas of natural vegetation, disturbed communities, and bare ground. Natural communities are also found around the perimeter of WAG 4. Areas outside the WAG 4 fenced boundary include sagebrush/rabbitbrush shrub-steppe, sagebrush-steppe on lava, and grasslands. These components are discussed in detail in the following sections.

7.2.4 Abiotic Components

CFA is located on the alluvial plain on the Big Lost River. The topography of the assessment area is relatively flat. The area is comprised of Typic Camborthids-Typic Calciorthids (TCC) soils (see Figure 7-2).

The TCC soils are alluvium, which is deposited by the Big Lost River. TCC soils are older than some of the other soil types and are further from the river. TCC soils are loams or silt loams over gravelly or sandy loams, and the surface is frequently hardened due to the alkaline conditions. Generally, TCC soils are not as fine as, nor found on the surface as, some of the other INEEL soil types. This soil type is often dry and generally alkaline and saline, impermeable, erodible, and has little organic accumulation in the upper layer (USDA 1975, 1980). Spring thaws and intense rainstorms may lead to significant soil erosion.

Root uptake of contaminants is a complex process that depends on various soil properties such as pH, cation-exchange capacity, and organic matter content. In addition, the process is highly variable from one plant species to another. While soil-plant relationships are not specifically considered as part of the WAG 4 ERA, this information is presented to support possible comprehensive analyses.

The climate at WAG 4 cannot be differentiated from that of the entire INEEL because meteorological data that are ultimately reported are collected in only two locations on the INEEL. Data reported here are collected at the CFA National Oceanic and Atmospheric Administration meteorological station. The average annual temperature is 5.4°C (41.7°F) with a mean annual precipitation of 22.2 cm

(8.74 in). Annual snowfall ranges from a low of about 30 cm (12 in.) to a high of about 102 cm (40 in.) and averages 66 cm (26 in.). Wind patterns at the assessment area are from the west-southwest or southwest approximately 40 percent of the time, and the average speed is 15.0 kph (9.3 mph) at 6.1 m (20 ft.). Wind direction the remaining 60 percent of the time is a combination of directions, predominantly due west or northwest.

Major stream flows that reach the INEEL terminate at the Big Lost River playas and sinks or the Birch Creek playa, in which most water is lost to evaporation and infiltration. Surface water flow and accumulation are generally limited to spring runoff and intense precipitation events within the INEEL site boundaries, and no major natural drainages occur at the CFA or nearby areas surrounding the facilities. Surface flow is limited to localized runoff, particularly from the parking lot and driveways of the existing facilities within WAG 4. No surface hydrology exists to support fish. Surface water impoundments at the CFA support aquatic vertebrate and invertebrate species (Cieminski 1993), however, none of these impoundments are included in the scope of current CERCLA activities at WAG 4. Consequently, the surface water pathway and aquatic receptors were not evaluated in this assessment. Groundwater is present; however, for this assessment, it is assumed that no pathways to surface ecological receptors exist for these sites.

7.2.5 Biotic Components

Wildlife species present in and around the CFA include birds, mammals, and reptiles that are associated with facilities, sagebrush-rabbitbrush, grasslands, and disturbed habitats, deciduous trees and shrubs, and water (e.g., facility ponds and drainage areas). Both aquatic and terrestrial species are potentially present. Sagebrush habitats in areas adjacent to facilities support a number of species including sage grouse and pronghorn (important game species) and areas of grassland provide habitat for species such as the western meadowlark *(Sturnella neglecta)* and mule deer *(Odocoileus hemionus)*, also a game species. Buildings, lawns and ornamental vegetation, and disposal/drainage ponds at WAG 4 are also utilized by a number of species such as waterfowl, raptors, rabbits, mule deer and bats. No areas of critical habitat as defined in the Code of Federal Regulations (40 CFR Part 300) are known to exist in or around CFA.

The flora and fauna existing around the CFA facility are representative of those found across the INEEL (Arthur et al. 1984; Reynolds et al. 1986) and are described in the following sections. Flora surrounding CFA was determined using a vegetation map constructed for the INEEL using LANDSAT imagery and field measurements from vegetation plots (Kramber et al. 1992). Fauna potentially existing in the vicinity of CFA was identified primarily from a 1986 vertebrate survey performed on the INEEL (Reynolds et al. 1986) and from data collected subsequent to the survey. While the flora and fauna present at CFA have not been verified with a comprehensive field survey, information presented here is supported by previous field surveys and observations as described in Appendix E.

7.2.5.1 Flora. The 15 INEEL vegetation cover classes defined using LANDSAT imagery data (Kramber et al. 1992) have been combined into eight cover classes for the WAGs (VanHorn et al. 1995). The vegetation surrounding CFA (shown on Figure 7-2) represents 5 vegetation cover classes, including sagebrush-steppe on lava, sagebrush-rabbitbrush, grassland, playa-bareground/disturbed areas, and juniper. A sixth cover class, lava, is shown in an area in which a stockpile of dark colored aggregate with the same spectral signature as that of lava or basalt. The species composition for each of these classes summarized on Table 7-4. Sagebrush/rabbitbrush is the predominant vegetation type. The dominant vegetation species within this community are the Wyoming big sagebrush *(Artemisia tridentata* spp. *wyomingensis)* and green rabbitbrush *(Chrysothamnus viscidiflorus)*. Grasslands present in the area consist primarily of wheatgrasses *(Agropyron* spp. and *Elymus* spp). The playa-bareground/disturbed cover class primarily represents areas associated with disturbances in and around WAG 4. Two isolated

Table 7-4. Vegetation cover class summary for areas in and surrounding WAG 4.

WAG ERA Vegetation Cover Class	INEEL Vegetation Cover Classes	Dominant Species
Grasslands	Steppe Basin Wildrye Grassland	*Leymus cinereus* *Descurainia sophia* *Sisymbrium altissimum* *Elymus lanceolatus* *Artemisia tridentata* ssp. *wyomingensis* *Elymus elymoides* *Chrysothamnus viscidiflorus*
Sagebrush/Rabbitbrush	Sagebrush-steppe off lava Sagebrush-winterfat Sagebrush-rabbitbrush	*Artemisia tridentata* ssp. *wyomingensis* *Chrysothamnus viscidiflorus* *Bromus tectorum* *Sisymbrium altissimum* *Achnatherum hymenoides*
Salt desert shrubs	Salt desert shrub	*Atriplex nuttallii* *Atriplex canescens* *Atriplex confertifolia* *Krascheninnikovia lanata*
Sagebrush-steppe on lava	Sagebrush-steppe on lava	*Artemisia tridentata* ssp. *wyomingensis* *Achnatherum hymenoides* *Chrysothamnus viscidiflorus*
Playa-bareground/disturbed areas	Playa-bareground/gravel borrow pits, old fields, disturbed areas, seedings	*Kochia scoparia* *Salsola kali* *Artemisia tridentata* ssp. *wyomingensis* *Chrysothamnus viscidiflorus*

areas of juniper shown on the figure have not been verified. These areas may represent other vegetation or structures having characteristics that result in the same spectural signature as juniper.

Areas of facility ornamental vegetation, (not represented on Figure 7-2), include lawns and deciduous trees and shrubs. Common bird species such as the American robin (*Turdus migratorus*) and house finch (*Carpodacus mexicanus*) and mammals including Nuttall's cottontail (*Sylvilagus nuttallii*) and the montane vole (*Microtus montanus*) utilize this vegetation. These areas also provide habitat for less common species such as the song sparrow (*Melospiza melodia*) and Bohemian waxwing (*Bombycilla garrulus*). These areas may draw particular species to areas of potential exposure or contamination that otherwise would not be present at CFA.

7.2.5.2 Fauna. A comprehensive list of fauna potentially present at and surrounding WAG 4 is presented in Appendix H. The list incorporates the concept of functional grouping as described in the Guidance Manual (VanHorn et al. 1995). The functional grouping approach is designed to group similar species to aid in analyzing the effects of stressors on INEEL ecosystem components. The primary purpose for functional grouping is to apply existing data from one or more species within the group to assess the risk to the group as a whole. Functional groups are used to perform a limited evaluation of exposures for all potential receptors and provide a mechanism for focusing subsequent analyses on receptors that best characterize potential contaminant effects.

Functional groups designed to be representative of receptors at WAG 4 have been identified from those listed in Appendix F. The functional groups evaluated in the WAG 4 ERA were selected with the assumption that those groups would be conservative indicators of effect for other similar groups. Species characteristics including trophic level, breeding, and feeding locations were used to construct functional groups for INEEL species. Individual groups were assigned a unique identifier consisting of a one- or two-letter code to indicate taxon (A = amphibians, AV = birds, M = mammals, R = reptiles, I = insects), and a three-digit code derived from the combination of trophic category and feeding habitats. For example, AV122 represents the group of seed-eating (herbivorous) bird species whose feeding habitat is the terrestrial surface and/or understory. The trophic categories (first digit in three-digit code) are as follows: 1 = herbivore, 2 = insectivore, 3 = carnivore, 4 = omnivore, and 5 = detrivore. The feeding habitat codes (second and third digits in three-digit code) are derived as follows:

- 1.0 Air
- 2.0 Terrestrial
  - 2.1 Vegetation canopy
  - 2.2 Surface/understory
  - 2.3 Subsurface
  - 2.4 Vertical habitat (man-made structures, cliffs, etc.)
- 3.0 Terrestrial/Aquatic Interface
  - 3.1 Vegetation canopy
  - 3.2 Surface/understory
  - 3.3 Subsurface
  - 3.4 Vertical habitat
- 4.0 Aquatic
  - 4.1 Surface water
  - 4.2 Water column
  - 4.3 Bottom

The list of species potentially present in the vicinity of WAG 4 was developed by updating 1986 data on the relative abundance, habitat use, and seasonal presence of fish, amphibians, reptiles, birds, and mammals recorded on the INEEL (Reynolds et al. 1986) and by communicating with INEEL researchers and personnel conducting ecological studies since 1986. Fauna that are not supported by the existing habitat or that are rare or uncommon or otherwise unlikely to be found in the CFA vicinity were not included in the literature search for species specific exposure and/or toxicity data. Those species are also listed in Appendix F.

Use of the CFA ponds by wildlife has not been formally documented and the frequency of use by wildlife is unknown. Ponds in and around other facilities are known to be frequented by waterfowl, including ducks, geese, mergansers, coots and scaup; shorebirds, including avocet, sandpipers, killdeer, willet, phalarope, and grebe; swallows; and passerines including blackbirds, sparrows, starlings, horned lark, and doves; and, to a limited extent, by raptors such as kestrel, ferruginous hawk, and northern harrier (Cieminski 1993). Mammals have also been observed at the disposal ponds despite the perimeter fencing. Species observed include small mammals, coyote, mule deer and pronghorn (Cieminski 1993).

Species potentially present at and surrounding WAG 4 represent all 23 INEEL avian functional groups and nine of 10 mammalian functional groups. Both reptilian functional groups are represented by species inhabiting the immediate area. No amphibians are known to be present and no surface hydrology exists to support fish. Aquatic invertebrates, however, are supported by habitat provided by facility disposal and drainage ponds (Cieminski 1993).

Both aquatic and terrestrial invertebrates and microorganisms are present at CFA. Invertebrates are important links in dietary exposure for wildlife, and also may function as good indicators for contaminant exposure in soil, aquatic systems, and vegetation uptake, and microorganisms also play an important role in ecosystem processes. A list of terrestrial invertebrates potentially present in and surrounding CFA is not currently available and these ecosystem components are not quantitatively assessed in the WAG 4 ERA.

Although some population studies have been conducted for cyclic rabbit and rodent populations and several game species (e.g., pronghorn, sage grouse, and raptors), no recent comprehensive studies have been conducted to assess either WAG-specific or INEEL-wide wildlife population status and trends associated with contaminant effects.

Wildlife species present in and around CFA include birds, mammals, and reptiles that are associated with facilities, lawns, ornamental trees and shrubs, sagebrush/rabbitbrush and grassland habitats, grasslands, disturbed areas and water (e.g., facility ponds and drainage areas). Both aquatic and terrestrial species are potentially present. The varying behaviors of these species include, but are not limited to, grazing and browsing on vegetation, burrowing and flying, and preying on insects and small mammals. The complexity of these behaviors is significant when considering the fate and transport of contaminants and the possibility of exposure to contaminants. Subsurface contamination can become surface contamination when translocated by burrowing animals, or can be introduced into the food web when plants uptake contamination and are then ingested by an herbivore. If prey, such as a small mammal, becomes contaminated by ingesting contaminated soil or vegetation, and is then captured by a predator, such as a ferruginous hawk, the contamination can be taken offsite when the hawk returns to its nest to feed nestlings. Scenarios for potential exposure of fauna to WAG 4 contaminants are discussed in Section 7.3.

The flora and fauna potentially present within WAG 4 are combined into a simplified food web model as presented on Figure 7-3. Variability in environmental conditions, such as population sizes or seasons, is not considered in this model, and a constant environment is assumed. Because both aquatic and terrestrial habitats are present, the model incorporates both terrestrial and aquatic species. However, only terrestrial linkages have been evaluated for this ERA. Depicted are the decomposers, producers (vegetation), primary consumers or herbivores (e.g., rodents), secondary consumers or carnivores (e.g., snakes), and tertiary or top carnivores (e.g., raptors) and the dietary relationships between each level. These relationships were incorporated to identify direct and indirect exposure to contaminants for the conceptual site model as discussed in Section 7.2.9. This model depicts the possible transport of WAG 4 contaminants through the food web.

7.2.5.3 Threatened, Endangered, and Other Species of Concern. A list of T/E and sensitive species was compiled from the U.S. Fish and Wildlife Service (USFWS) (letter dated July 16, 1997), the Idaho Department of Fish and Game Conservation Data Center threatened, endangered, and sensitive species for the State of Idaho (CDC 1994); and RESL documentation for the INEEL (Reynolds et al. 1986). T/E or sensitive species that may be found on the INEEL are listed in Table 7-5. Those species with a potential presence at WAG 4 are listed in bold text in the table. The USFWS no longer maintains a candidate species (C2) listing but addresses former C2 species as "species of concern" (USFWS 1996). The C2 designation is retained here to maintain consistency with INEEL ERAs conducted prior to the change in USFWS listing procedures.

No areas of critical habitat, as defined in the Code of Federal Regulations (CFR) (CFR 300 40), are known to exist in, at or near WAG 4. At the time the WAG 4 SLERA was conducted, Oxytheca *(Oxytheca dendroidea)* was listed as a sensitive plant species with the U.S. Bureau of Land Management (BLM) and the Idaho Native Plant Society (INPS)/Idaho Fish and Game Conservation Data Center. This

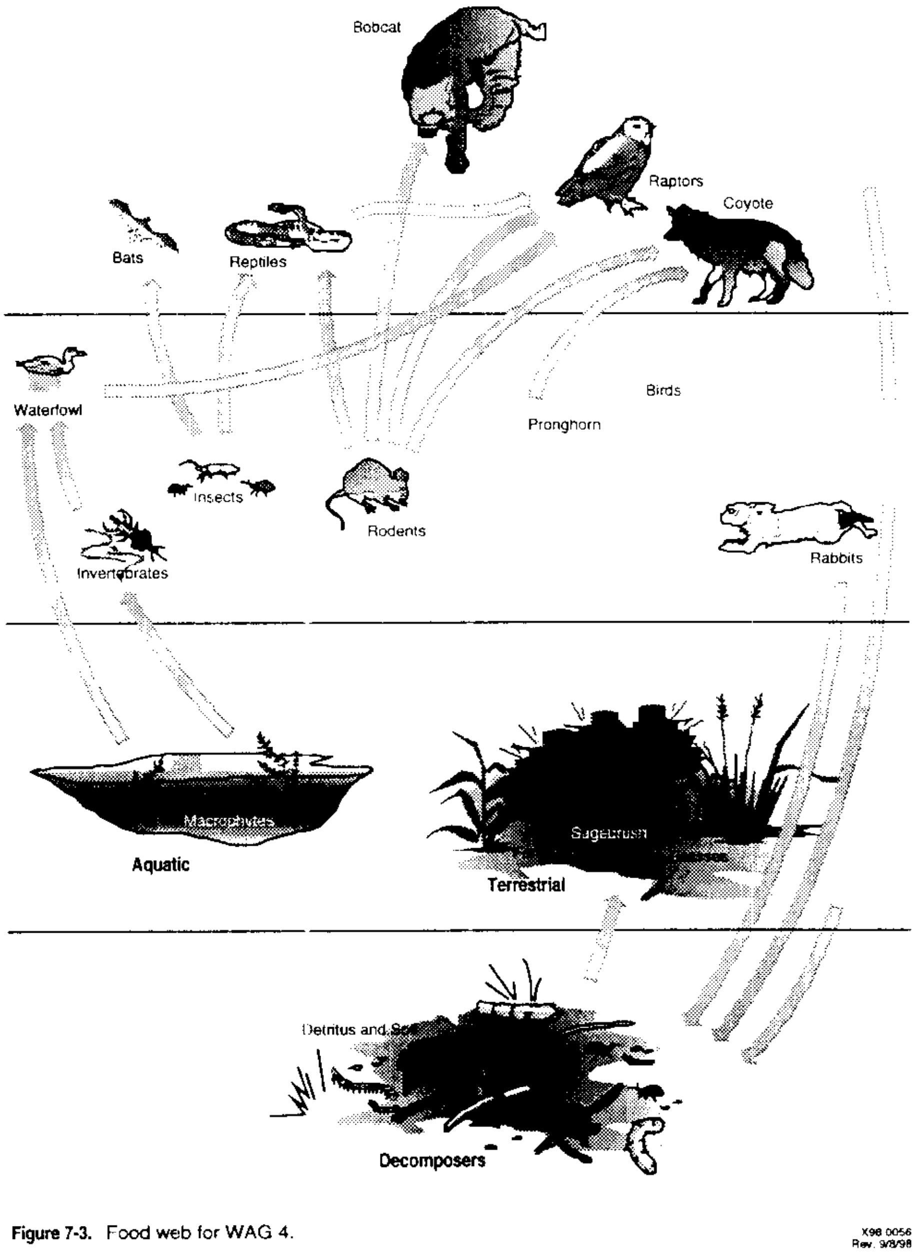

Figure 7-3. Food web for fauna at WAG 4.

Table 7-5. Threatened and endangered species, special species of concern, formerly Category 2 (C2) species, and sensitive species that may be found on the INEEL. Species in bold are those assessed in the WAG 4 ERA.

Common Names[a,b]	Scientific Name[a,b]	Federal Status[c,d]	State Status[d]	BLM Status[d]	USFS[g] Status[d]
Plants					
Lemhi milkvetch	*Astragalus aquilonius*	X	S	S	S
Painted milkvetch[f]	*Astragalus ceramicus var. apus*	3c	R	X	X
Plains milkvetch	*Astragalus gilviflorus*	NL	1	S	S
Winged-seed evening primrose	*Camissonia pterosperma*	NL	S	X	X
Nipple cactus[f]	*Coryphantha missouriensis*	NL	R	X	X
Spreading gilia	*Ipomopsis (=Gilia) polycladon*	NL	2	S	X
King's bladderpod	*Lesquerella kingii var. cobrensis*	X	M	X	X
Tree-like oxytheca[f]	*Oxytheca dendroidea*	NL	R	R	X
Inconspicuous phacelia[e]	*Phacelia inconspicua*	C2	SSC	S	S
Puzzling halimolobos	*Halimolobos perplexa var. perplexa*	X	X	X	S
Ute ladies' tresses[e]	*Spiranthes diluvialis*	LT	X	X	X
Birds					
Peregrine falcon	***Falco peregrinus***	**LE**	**E**	X	X
Merlin	*Falco columbarius*	NL	X	S	X
Gyrfalcon	*Falco rusticolus*	NL	SSC	S	X
Bald eagle	***Haliaeetus leucocephalus***	**LT**	**T**	X	X
Ferruginous hawk	*Buteo regalis*	C2	SSC	S	X
Black tern	***Chlidonias niger***	C2	X	X	X
Northern pygmy owl[e]	*Glaucidium gnoma*	X	SSC	X	X
Burrowing owl	***Athene cunicularia***	**C2**	X	**S**	X
Common loon	*Gavia immer*	X	SSC	X	X
American white pelican	*Pelicanus erythrorhynchos*	X	SSC	X	X
Great egret	*Casmerodius albus*	X	SSC	X	X
White-faced ibis	***Plegadis chihi***	C2	X	X	X
Long-billed curlew	*Numenius americanus*	3c	X	S	X
Loggerhead shrike	***Lanius ludovicianus***	**C2**	NL	**S**	X
Northern goshawk	***Accipiter gentilis***	**C2**	**S**	X	**S**
Swainson's hawk	*Buteo swainsoni*	X	X	S	X
Trumpeter swan	*Cygnus buccinator*	C2	SSC	S	S
Sharptailed grouse	*Tympanuchus phasianellus*	C2	X	S	S
Boreal owl	*Aegolius funereus*	X	SSC	S	S

Table 7-5. (continued).

Common Names[a,b]	Scientific Name[a,b]	Federal Status[c,d]	State Status[d]	BLM Status[d]	USFS[g] Status[d]
Flammulated owl	*Otus flammeolus*	X	SSC	X	S
Mammals					
Gray wolf[h]	***Canis lupus***	**LE/XN**	**E**	X	X
Pygmy rabbit	***Brachylagus (=Sylvilagus) idahoensis***	**C2**	**SSC**	**S**	X
Townsend's western big-eared bat	***Corhynorhinus (=Plecotus) townsendii***	**C2**	**SSC**	**S**	**S**
Merriam's shrew	*Sorex merriami*	X	S	X	X
Long-eared myotis	***Myotis evotis***	**C2**	X	X	X
Small-footed myotis	***Myotis ciliolabrum (=subulatus)***	**C2**	X	X	X
Western pipistrelle[e]	*Pipistrellus hesperus*	NL	SSC	X	X
Fringed myotis[e]	*Myotis thysanodes*	X	SSC	X	X
California myotis[e]	*Myotis californicus*	X	SSC	X	X
Reptiles and Amphibians					
Northern sagebrush lizard	***Sceloporus graciosus***	**C2**	X	X	X
Ringneck snake[e]	*Diadophis punctatus*	C2	SSC	S	X
Night snake[f]	*Hypsiglena torquata*	X	X	R	X
Insects					
Idaho pointheaded grasshopper[e]	*Acrolophitus punchellus*	C2	SSC	X	X
Fish					
Shorthead sculpin[e]	*Cottus confusus*	X	SSC	X	X

a. This list was compiled from a letter from the U.S. Fish and Wildlife Service (USFWS July 16, 1997) for threatened or endangered, and sensitive species listed by the Idaho Department of Fish and Game Conservation Data Center (CDC 1994 and IDFG web site 1997) and Radiological Environmental Sciences Laboratory documentation for the INEL (Reynolds et al., 1986).

b. Species in **bold** are those species individually assessed in the WAG 4 ERA.

c. The USFWS no longer maintains a candidate (C2) species listing but addresses former listed species as "species of concern" (USFWS April 30, 1996). The C2 designation is retained here to maintain consistency between completed and ongoing INEEL ERA assessments.

d. Status codes: INPS = Idaho Native Plant Society; S = sensitive; 2 = State Priority 2 (INPS); 3c = no longer considered for listing; M=State of Idaho monitor species (INPS); NL = not listed; 1 = State Priority 1 (INPS); LE = listed endangered; E = endangered; T = threatened; XN = experimental population, nonessential; SSC = species of special concern; and C2 = see item c, formerly Category 2 (defined in CDC 1994). BLM = Bureau of Land Management; R = removed from sensitive list (non-agency code added here for clarification).

e. No documented sightings at the INEEL; however, the ranges of these species overlap the INEEL and are included as possibilities to be considered for field surveys.

f. Recent updates resulting from Idaho State Sensitive Species meetings (BLM, USFWS, INPS, USFS) - (INPS 1995; 1996)

g. United States Forest Service (USFS) Region 4.

h. Anecdotal evidence exists that isolated wolves have occurred on the INEEL, but it is unlikely wolves regularly hunt or breed on site (Morris 1998).

species has since been determined to occur in greater abundance than originally believed and has been removed from the INPS and BLM lists (CDC 1996). No T/E plant species have been recorded at CFA or in areas immediately surrounding the facility.

Avian T/E species or species of concern with a potential for occurrence in the vicinity of WAG 4 include the ferruginous hawk (*Buteo regalis*), peregrine falcon (*Falco peregrinus*), northern goshawk (*Accipiter gentilis*), loggerhead shrike (*Lanius ludovicianus*), burrowing owl (*Athene cunicularia*), bald eagle (*Haliaeetus leucocephalus*), white-faced ibis (*Plegadis chihi*), black tern (*Childonias niger*), and trumpeter swan (*Cygnus buccinator*). The bald eagle and peregrine falcon are federally listed T/E species. The remaining avian species are species of concern (formerly C2).

Four mammal species of concern (formerly C2) potentially occur in the vicinity of WAG 4. These include the pygmy rabbit [*Brachylagus (=Sylvilagus) idahoensis*], Townsend's western big-eared bat [*Corhynorhinus (=Plecotus) townsendii*], the long-eared myotis *(Myotis evotis)*, and the small-footed myotis [*Myotis ciliolabrum (=subulatus)*]. Presence of the gray wolf has not been verified at the INEEL, however this federally listed species has also been included in the assessment for completeness. The northern sagebrush lizard (*Sceloporous graciosus*) is the only reptile species of concern with a potential presence at WAG 4.

In 1996, field surveys were conducted in the areas surrounding WAG 4 facilities to assess the presence and use of those areas by T/E species or other species of concern (i.e., species formerly designated as C2). The survey findings have been documented in draft reports that include survey protocols and results for WAG 4 (Morris 1998). Specific information collected and reported for each T/E or species of concern includes:

- Date and conditions under which the surveys were conducted;
- Area encompassed by the surveys (global positioning system [GPS] mapping where practical);
- GPS locations for observed habitat, sign, and species sighted (where practicable);
- Habitat description, the proximity to WAG or site, and an estimate of whether contaminated sites or areas are within the home range of members of the species in question;
- Species presence, abundance, current site use, past site use (historical sightings or surveys), and anticipated site use (professional judgment); and
- An estimated site or area population (where possible).

In August 1997 a field survey was conducted for individual sites of concern within CFA facilities that have been or are currently being evaluated as part the WAG 4 ERA. An on-site inspection was conducted and each site of contamination was evaluated for habitat qualities and potential to support INEEL T/E species or other species of concern. The attributes evaluated include:

- Size
- Substrate (gravel, asphalt, lawn, etc.)
- Natural or manmade features that may attract wildlife (e.g. water, lights)

- Proximity to areas or sites of facility activity
- Presence and availability of food or prey
- Available nesting, roosting or loafing habitat
- Signs of wildlife use
- Prior history, known wildlife sightings or use.

Attributes were subjectively rated for positive contributions to overall habitat suitability. An overall site rating of high, medium, low, or none was assigned based on the number of positive habitat features and probability that the species of concern may use or uses the site. The conventions upon which ratings were assigned for individual habitat attributes are summarized in Table 7-6. Although T/E and species of concern were of primary consideration, potential use by game species and unique populations (Great Basin spadefoot toad and Merriam's shrew) was also assessed.

Sites for which risk to receptors has been calculated (HQ>1) but for which no positive habitat attributes were observed are unlikely to contribute to wildlife exposures. Sites rated overall as "low" are those having one or two positive attributes and therefore potential for incidental use by wildlife. These sites also may be generally discounted as contributing significantly to chronic wildlife contaminant exposures.

Results of the survey and ratings for the sites of concern are summarized in Table 7-7 and are discussed for each species of concern in the paragraphs below. These surveys were conducted to allow evaluation of sites of concern in an ecological context. The duration and rigor of these surveys were not adequate to verify presence or frequency of occurrence, but were conducted to allow evaluation of WAG 4 sites of concern in an ecological context. The rankings for sites presented here are subjective, based on professional opinion supported by limited observation. Surveys for some species were also supported by GIS analyses using recently developed habitat models.

Table 7-6. Habitat rating conventions for WAG 4 sites of concern.

Attribute	Examples
Size	Areas having physical dimensions too small to support species of interest were rated "none" unless enhanced by other attributes. Large, unconfined areas adequate to support wildlife were assigned higher ratings.
Substrate	Asphalt = none, gravel =low, lawn, soil = medium-high for some species, disturbed vegetation community = medium to high, natural vegetation community = high.
Natural or manmade features	Water = high (water [permanent or ephemeral] is an important component in desert systems); lights = medium (both attract and/or support insects and consequently bats and insectivorous birds [i.e., swallows, nighthawks])
Proximity to areas of activity	Proximity to areas or sites of moderate or heavy activity may reduce desirability. Sites associated with buildings and facilities may be more suitable if abandoned or little used (i.e., bat roosts).
Nesting, roosting, or loafing habitat	Structures such as fence and power poles adjacent to open fields afford perches for roosting and hunting etc.
Signs of wildlife use	Signs of wildlife use that qualitatively feed the evaluation. Examples of these signs include observation of animals, tracks, hair, or scat.
Prior history	Documented or reported sightings.

Table 7-7. Summary of WAG 4 sensitive species survey completed on August 20, 1997.

WAG 4 Site #	Black Tern	Trumpeter Swan	White-faced Ibis	Burrowing Owl	Ferruginous Hawk	Peregrine Falcon	Loggerhead Shrike	Bald Eagle	Bats	Merriam's Shrew	Pygmy Rabbit	Northern Sagebrush Lizard	Spadefoot Toad	Game species	Comments
CFA-01				H	H	H	M	M	L			H		M	Landfills, crested wheatgrass plantings, power lines and fence perching
CFA-02															Landfills, crested wheatgrass plantings, power lines and fence perching
CFA-03															Landfills, crested wheatgrass plantings, power lines and fence perching
CFA-04				H	H	H	H	M	M		M	H		H	Unfenced, ephemeral water, native and planted communities, good perches, low activity
CFA-05				M	L	L	L		L	L	L	H		M	Unfenced, native community, gravel substrate, intermittent water, adjacent powerlines
CFA-10					L	L	L		L			M		L	Small area, gravel substrate, open gates, weedy and good cover for small mammals
CFA-12														L	Adjacent to building wall, landscaped bed, adjacent lawn, removal action, rabbits, killdeer, mule deer
CFA-26															Asphalt adjacent to railroad tracks, building overlies site; eliminated from assessment.
CFA-40												L			Gravel substrate, open wire fencing, adjacent to warehouse, excessed equipment, small animal cover
CFA-41												L			Gravel substrate, open wire fencing, adjacent to warehouse, excessed equipment, small animal cover
CFA-43															Lead storage area
CFA-50															Gravel substrate, adjacent to railroad tracks, shallow well, removal action, elevated metals

Postive habitat attributes:
H = High
M = Medium
L = Low

A blank indicates no positive habitat attributes.

Bald Eagle—Sites CFA-01 and CFA-04 are the only CFA sites posing a potential for exposure since these sites are large, unfenced areas that are removed from facility activity and provide good perching areas. Sites CFA-02, CFA-03, CFA-05, CFA-10, CFA-12, CFA-26, CFA-40, CFA-41, CFA-43, and CFA-50 have no positive habitat features and are unlikely to contribute to bald eagle contaminant exposures.

Burrowing Owl—Three sites (CFA-01, -04, and -05) demonstrated positive habitat features for this species. Both CFA-01 and CFA-04 were rated "high" in part due to size and potential nesting habitat. CFA-05 was rated "medium" due to the presence of a gravel substrate that may restrict nesting but may be a positive attribute for hunting (i.e., native community and perching structures).

Loggerhead Shrike—Sites CFA-01 ("medium") and CFA-04 ("high") both pose potential for exposure since these areas provide perches and have, or are adjacent to native communities. There is little likelihood that exposure to loggerhead shrikes will occur as a result of contaminants associated with sites CFA-02, CFA-03, CFA-12, CFA-26, CFA-40, CFA-41, CFA-43, and CFA-50. Sites CFA-05 and CFA-10 both were rated as having a "low" potential for contributing to loggerhead shrike contaminant exposures.

Northern Goshawk, Ferruginous Hawk, and Peregrine Falcon—Sites CFA-01 and CFA-04 both show a "high" potential for exposure primarily because of large open areas and available perches for hunting. No positive habitat features were found at sites CFA-02, CFA-03, CFA-12, CFA-26, CFA-40, CFA-41, CFA-43, and CFA-50. Sites CFA-05 and CFA-10 both show a "low" potential for exposure to contaminants of concern.

Gray Wolf—Anecdotal evidence of isolated wolves on the INEEL exists, but it is unlikely wolves regularly hunt or breed on site (Morris 1998). The gray wolf is a federally listed endangered species and is, therefore, represented in this assessment by functional group M322 as a conservative measure to ensure all potential receptors having special status have been evaluated.

Pygmy Rabbit—Only sites CFA-04 and CFA-05 demonstrate positive habitat features that may support pygmy rabbits. Presence of native shrub communities, ephemeral water and low activity around and near the CFA-04 site constitute "medium" potential for occurrence of pygmy rabbits. Although similar to CFA-04, a gravel substrate at site CFA-05 is likely to restrict burrowing by pygmy rabbits and is, therefore, rated overall as having "low" potential for contributing significantly to pygmy rabbit contaminant exposures.

Northern Sagebrush Lizard—Sites CFA-01, CFA-04 and CFA-05 have the greatest potential for contributing to sagebrush lizard contaminant exposures at WAG 4. It is unlikely sagebrush lizards will be exposed to contaminants associated with WAG 4 sites CFA-02, CFA-03, CFA-12, CFA-26, CFA-43 and CFA-50. CFA-40 and CFA-41 have a slightly higher potential for exposure and therefore were rated as "low". Because CFA-10 is a small area with open gates and weeds that provide a good cover for small animals, this site was rated as having "medium" exposure potential.

Townsend's Western Big-Eared Bat, Long-Eared Myotis, and Small-Footed Myotis—The insect prey associated with the large areas of native vegetation at CFA-04 has medium potential for attracting feeding bats. Other sites which are open and support significant areas of vegetation include CFA-01, CFA-05 and CFA-10. However, these areas primarily support non-native communities and therefore pose lower potential for use by bats.

Black Tern, Trumpeter Swan, and White-Faced Ibis—The black tern, trumpeter swan, and white-faced ibis are associated exclusively with water sources and have also been recorded less than seven times site wide. Because CFA surface water impoundments which may be frequented by these species are not included in the scope of current WAG 4 CERCLA activities, they and other aquatic species were not evaluated in the ERA.

Potential risks associated with contaminant exposures for T/E and species of concern are of interest for both individuals and populations. Therefore, those species most likely to contact WAG 4 sites and contaminants of concern have been evaluated for individual exposures. Other species considered very rare INEEL-wide (see Appendix F, Table F-2) and considered unlikely to receive chronic doses through frequenting WAG 4 and surrounding areas are represented through evaluation of the functional group with which they are associated.

T/E and species of concern that were individually evaluated for exposure to contaminants at WAG 4 are listed in boldface text (see Table 7-5). These include the peregrine falcon, bald eagle, burrowing owl, loggerhead shrike, northern goshawk, pygmy rabbit, Townsend's western big-eared bat, long-eared myotis, small-footed myotis, gray wolf, and northern sagebrush lizard, all of which were evaluated for direct and indirect exposure to surface soil contaminants.

7.2.6 Stressor Identification and Characterization

DOE Guidance (DOE 1993) defines a stressor as "any physical, chemical, or biological entity that can induce adverse response." CERCLA is primarily concerned with the effects of contaminant stressors. Contaminant stressors at WAG 4 include a variety of radionuclides, organics, and metals identified at multiple sites.

Human Health Concentration Data—Data from the various human health risk assessments at the sites are solely available for the ERA. For the human health assessment, concentration data were divided into 0 to 0.15 m (0 to 0.5 ft), 0 to 1.22 m (0 to 4 ft), and 0 to 3 m (0 to 10 ft) average concentrations. For the WAG ERA, the 0 to 15 cm (0 to 0.5 ft) concentrations were used to characterize surficial soil concentrations. The subsurface concentrations, considered to be 15 cm to 3 m (0.5 to 10 ft), are based on the 15 cm to 3 m (0.5 to 10 ft) concentrations. When only 0 to 3 m (0 to 10 ft) concentrations were available for a site, these concentrations were also used to characterize 0 to 15 cm (0 to 0.5 ft) concentrations.

If data were not available from ERIS, source terms were obtained from Track 1 and Track 2 documentation. The maximum concentration from either surface or subsurface concentrations was used in all cases unless noted otherwise (see Tables 7-8 and 7-9).

7.2.6.1 Screening of Contaminants. This section provides the screening of contaminants against both background concentrations (Rood et al. 1995) and ecologically based screening levels (EBSLs) to identify COPCs for the WAG ERA. All EBSLs were calculated specifically for use at the INEEL. The complete methodology and documentation of the development of EBSLs will be included in the OU 10-04 Work Plan. Appendix I presents a summary of the approach.

The sites and the contaminants at those sites to be evaluated in this assessment were previously identified in Table 7-3. Tables 7-8 through 7-10 present the summary of the results comparing maximum site concentrations to the EBSL and background values (if available) for inorganic, organic, and radionuclide contaminants, respectively. The concentrations are maximum site concentrations unless otherwise noted. The site information is detailed in Appendix K. However, for sites that are not

Table 7-8. Screening of nonradionuclide inorganic contaminants. Bold text indicates that contaminant concentration exceeded EBSL and background.

Contaminant	Aluminum[c]	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium[c]	Chromium III[d]	Cobalt
Background (mg/kg)[a]	1.60E+04	4.80E+00	5.80E+00	3.00E+02	1.80E+00	2.20E+00	2.40E+04	3.30E+01	1.10E+01
EBSL (mg/kg)[b]	4.27E+00	7.47E-01	8.76E-01	9.74E-02	7.14E-01	2.36E-03	NA	3.25E+01	4.54E-01
CFA-01	7.87E+03	1.5E+00	6.80E+00[e]	2.15E+02	2.50E+00[e]		3.79E+04	**5.30E+01**	9.70E+00
CFA-02	1.39E+04		**1.72E+01**	2.69E+02	1.50E+00	2.60E+00[f]	1.00E+05	2.19E+01	9.90E+00
CFA-03	7.86E+03		8.1E+00[e]	1.75E+02	1.10E+00	1.30E+00	3.55E+04	1.61E+01	8.80E+00
CFA-04	2.90E+04		**2.24E+01**	**1.11E+03**	9.70E-01	**6.80E+00**	1.01E+05	**2.37E+02**	**1.28E+01**
CFA-05 Ditch	3.52E+04	5.80E+00[g]	**1.98E+01**	**4.34E+02**		**3.80E+01**	4.76E+04	**9.13E+01**	**1.50E+01**
CFA-05 Pond	2.25E+04	3.60E+00	**9.02E+00**	2.54E+02		**6.80E+00**	1.10E+05	**3.49E+01**	1.16E+01[h]
CFA-06			**1.45E+01**						
CFA-08	1.47E+04	1.50E+00	**1.41E+01**	**4.66E+02**	2.50E+00[e]	2.50E+00[h]	9.32E+04	**7.76E+01**	8.40E+00
CFA-10	9.13E+03	**9.50E+00**	**1.16E+01**	2.71E+02	8.50E-01	**7.30E+00**	2.44E+04	**1.02E+02**	**1.57E+01**
CFA-12									
CFA-13	6.45E+03	**1.15E+01**	**1.09E+01**	1.15E+02	4.70E-01	**7.37E+00**	6.77E+04	**1.79E+02**	6.09E+00
CFA-15	1.56E+04		5.57E+00	2.69E+02			5.96E+04	2.20E+01	
CFA-17/47[i]									
CFA-21									
CFA-23									
CFA-24									
CFA-25									
CFA-26[d]									
CFA-27									
CFA-28									
CFA-29									

Table 7-8. (continued).

Contaminant	Aluminum[c]	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium[c]	Chromium III[d]	Cobalt
Background (mg/kg)[a]	1.60E+04	4.80E+00	5.80E+00	3.00E+02	1.80E+00	2.20E+00	2.40E+04	3.30E+01	1.10E+01
EBSL (mg/kg)[b]	4.27E+00	7.47E-01	8.76E-01	9.74E-02	7.14E-01	2.36E-03	NA	3.25E+01	4.54E-01
CFA-30									
CFA-31									
CFA-32									
CFA-34									
CFA-35									
CFA-37									
CFA-38									
CFA-40									
CFA-41									
CFA-43									
CFA-44									
CFA-45									
CFA-48	5.69E+03		3.20E+00	1.28E+02	4.10E-01		2.13E+04	1.92E+01	5.60E+00
CFA-49									
CFA-50									
CFA-51	5.90E+03		7.00E+00[e]	2.10E+02		**1.40E+01**	2.40E+04	1.90E+01	6.00E+00

Table 7-8. (continued).

Contaminant	Copper	Iron[c]	Lead	Magnesium[c]	Manganese	Mercury	Nickel	Nitrate
Background (mg/kg)[a]	2.20E+01	2.40E+04	1.70E+01	1.20E+04	4.90E+02	5.00E-02	3.50E+01	NA
EBSL (mg/kg)[b]	2.11E+00	NA	7.17E-02	2.30E+00	1.41E+01	6.13E-03	2.69E+00	3.20E+01
CFA-01	**7.34E+01**	1.60E+04	**9.66E+01**					
CFA-02	3.02E+01[k]	2.07E+04	**2.55E+02**	7.22E+03	4.99E+02	**1.90E-01**	2.96E+01	
CFA-03	1.53E+01	1.35E+04	1.73E+01[m]	6.73E+03	3.22E+02		2.38E+01	
CFA-04	**3.65E+02**	2.29E+04	**4.93E+01**	1.69E+04	4.41E+02	**4.39E+02**	**3.55E+02**	**9.00E+01**
CFA-05 Ditch	**3.42E+02**	3.06E+04	**6.31E+02**	1.14E+04	**7.67E+02**	**5.80E-01**	**3.67E+01**	
CFA-05 Pond	**5.86E+01**	2.51E+04	**1.06E+02**	1.35E+04	**5.74E+02**		2.63E+01	
CFA-06			**1.53E+02**					
CFA-08	**3.30E+01**	2.45E+04	**2.23E+01**	1.53E+04	6.12E+02[n]	**5.10E-01**	**4.51E+01**	1.10E+00
CFA-10	**2.59E+02**	7.35E+04	**3.30E+03**	6.00E+03	**5.09E+02**	**9.00E-02**	**1.11E+02**	
CFA-12								
CFA-13	**1.90E+03**	1.42E+04	**7.25E+02**	1.27E+04	2.84E+02	**1.97E+00**	**8.51E+01**	
CFA-15	**2.11E+01**	2.26E+04	1.57E+01	1.04E+04	4.31E+02	**4.20E-01**	2.54E+01	
CFA-17/47[j]								
CFA-21								
CFA-23								
CFA-24								
CFA-25								
CFA-26[d]								
CFA-27								
CFA-28								

Table 7-8. (continued).

Contaminant	Copper	Iron[c]	Lead	Magnesium[c]	Manganese	Mercury	Nickel	Nitrate
Background (mg/kg)[a]	2.20E+01	2.40E+04	1.70E+01	1.20E+04	4.90E+02	5.00E-02	3.50E+01	NA
EBSL (mg/kg)[b]	2.11E+00	NA	7.17E-02	2.30E+00	1.41E+01	6.13E-03	2.69E+00	3.20E+01
CFA-29								
CFA-30								
CFA-31								
CFA-32								
CFA-34								
CFA-37								
CFA-38								
CFA-40								
CFA-41								
CFA-43			**3.67E+01**					
CFA-44			**5.11E+01**					
CFA-45								
CFA-48	1.55E+01	1.16E+04	**4.31E+01**	3.68E+03	2.14E+02	**1.80E-01**	1.74E+01	
CFA-49								
CFA-50								
CFA-51	**2.50E+02**	1.40E+04	**3.70E+01**	4.50E+03	2.10E+02		3.40E+01	

Table 7-8. (continued).

Contaminant	Potassium[c]	Selenium	Silver	Sodium[c]	Sulfide[q]	Thallium	Vanadium	Zinc
Background (mg/kg)[a]	4.30E+03	2.20E-01	NA	3.20E+02	NA	4.30E-01	4.00E+01	1.50E+02
EBSL (mg/kg)[b]	NA	8.11E-02	2.99E+00	1.07E+02	1.72E+01	1.17E-01	2.55E-01	6.37E+00
CFA-01	2.62E+03		**1.95E+01**	2.60E+02		4.2E-01	3.02E+01	**2.30E+02**
CFA-02	3.50E+03			3.13E+02			3.75E+01	1.07E+02
CFA-03	2.06E+03	4.90E-01[p]	9.30E-01	2.43E+02			3.34E+01	1.03E+02
CFA-04	3.77E+03		**1.21E+02**	4.47E+03			**5.56E+01**	1.31E+02
CFA-05 Ditch	5.43E+03			6.06E+02	9.20E+00	6.90E-01[r]	**4.72E+01**	**8.58E+02**
CFA-05 Pond	5.66E+03			1.10E+03		4.20E-01	3.41E+01	**2.41E+02**
CFA-06								
CFA-08	2.31E+03	**1.40E+00**	**2.41E+01**	9.16E+02			3.61E+01	1.62E+02[s]
CFA-10	2.15E+03		2.30E+00	2.16E+02			2.74E+01	**1.15E+03**
CFA-12								
CFA-13	1.19E+03	**5.43E-01**	**1.94E+01**	4.22E+02		2.60E-01	1.94E+01	**3.02E+02**
CFA-15	2.23E+03		4.20E-01	5.54E+02		2.00E-01	3.03E+01	7.96E+01
CFA-17/47[i]								
CFA-21								
CFA-23								
CFA-24								
CFA-25								
CFA-26								
CFA-27								
CFA-28								

Table 7-8. (continued).

Contaminant	Potassium[c]	Selenium	Silver	Sodium[c]	Sulfide[g]	Thallium	Vanadium	Zinc
Background (mg/kg)[a]	4.30E+03	2.20E-01	NA	3.20E+02	NA	4.30E-01	4.00E+01	1.50E+02
EBSL (mg/kg)[b]	NA	8.11E-02	2.99E+00	1.07E+02	1.72E+01	1.17E-01	2.55E-01	6.37E+00
CFA-29								
CFA-30								
CFA-31								
CFA-32								
CFA-34								
CFA-37								
CFA-38								
CFA-40								
CFA-41								
CFA-43								
CFA-44								
CFA-45								
CFA-48	1.18E+03		2.40E+00	1.27E+02				
CFA-49								
CFA-50								
CFA-51	1.20E+03	**6.00E-01**		1.00E+02			2.20E+01	**3.40E+02**

Table 7-8. (continued).

Contaminant	Potassium[c]	Selenium	Silver	Sodium[c]	Sulfide[q]	Thallium	Vanadium	Zinc
Background (mg/kg)[a]	4.30E+03	2.20E-01	NA	3.20E+02	NA	4.30E-01	4.00E+01	1.50E+02
EBSL (mg/kg)[b]	NA	8.11E-02	2.99E+00	1.07E+02	1.72E+01	1.17E-01	2.55E-01	6.37E+00

a. Background values (mg/kg) are the 95%/95% UTL for composite samples (Rood, Harris and White, 1996).

b. The minimum EBSL (mg/kg) for all receptors and functional groups.

c. As with the human health, it is appropriate to screen six inorganic constituents which are not associated with toxicity under normal circumstances. These include aluminum, calcium, iron, magnesium, potassium, and sodium. These will be eliminated if the concentration is less than 10 times background.

d. Chromium was assessed as chromium (III) since chromium is not expected to persist in the environment at the INEEL in the chromium VI form (Bartlett and Kimble, 1976; Rai et al., 1989). Additionally, 10 grid locations at PBF-10 (a dried pond site in 1965) were sampled for both chromium III and VI. The ratio of chromium III to VI averaged 0.0085 (with a range of 0.00017 to 0.053). Based on this information and the ratio of chromium III to VI EBSLs (0.162 to 3.25 [0.05]), it is unlikely that chromium VI would pose a risk unless chromium III first was shown to be a risk.

e. As discussed in the human health assessment, arsenic and beryllium are commonly detected in INEEL soil at concentrations slightly higher than background values. However, neither contaminant is associated with waste-producing processes at WAG 4. Therefore, arsenic at CFA-01, CFA-03, and CFA-51 and beryllium at CFA-01 and CFA-08 were eliminated from further evaluation in the ERA.

f. Cadmium at CFA-02—1 sample out of 21 exceeded background (1/21 = FOE of <5%). This concentration, 2.6 mg/kg, is below the 95%/99% UTL (2.7 mg/kg). It is warranted to remove the site based on this criteria when the FOE of the 95%/95% UTL for background is less than 5% (see Section 5.2 Rood et al., 1996).

g. Antimony at CFA-05—2 samples out of 61 exceeded background (2/61 = frequency of exceedence [FOE] of 3%). These concentrations are 5.8 mg/kg (BN *J flagged) and 5.6 mg/kg (BN flagged); the next highest level was 4.6 mg/kg. Therefore, antimony is removed as a contaminant of concern at this site.

h. Cobalt is eliminated because out of 22 samples, two slightly exceeded background (11.6 and 11.4) both at depth (below 6 ft).

i. Cadmium at CFA-08—1 sample out of 21 exceeded background (1/21 = FOE of <5%). This concentration, 2.5 mg/kg, is below the 95%/99% UTL (2.7 mg/kg). It is warranted to remove the site based on this criteria when the FOE of the 95%/95% UTL for background is less than 5% (see Section 5.2 Rood et al., 1996).

j. Post remediation results presented here include only the 69 locations that were resampled at CFA-17/47.

k. The copper at CFA-02 was eliminated as a contaminant of concern: 22 samples were collected at this location. The 3.02 mg/kg concentration was from a grab sample and does not exceed 95%/95% of 32 mg/kg for grab samples (Rood et al. 1996). The next highest level was 20.8 mg/kg.

l. Manganese at CFA-02 was eliminated as a contaminant of concern: the largest concentration of 22 samples is 4.99E+02 mg/kg (NJP flag). The next highest level is 395 mg/kg.

m. Lead at CFA-03—1 sample out of 12 exceeded background (17.3 mg/kg). This sample was NJ flagged indicating that lead was positively identified but the associated numerical value may not be consistent with the amount actually present in the environment. Therefore, this contaminant was eliminated as a COPC at this site.

n. Manganese at CFA-08 is eliminated as a contaminant of concern: only one concentration (NJ flag) out of 20 samples, is greater than background. The next highest level is 408 mg/kg (see Appendix B).

p. Selenium at CFA-03 was eliminated as a contaminant of concern: 12 samples were collect at this site. Concentrations ranged from ND to 0.49 mg/kg. The three concentrations (0.49, 0.45, and 0.43) were flagged with BNJ, meaning the analyte was positively identified but the associated numerical value may not be consistent with amount actually present. The remaining levels were below the detection limit. Selenium is not expected to have been released at this site.

q. Sulfide values at CFA-05 were screened using sulfate EBSL.

r. Thallium at CFA-05 was eliminated as a contaminant of concern: 1 sample out of 52 exceeded background (FOE <2%). Sample was taken at 6–6.5 ft below surface. The next highest hit was 0.42 mg/kg.

s. Zinc at CFA-08 was eliminated as a contaminant of concern: 1 concentration (NJ flag), out of 21 samples, is greater than background. The next highest level is 1.47E+02 mg/kg.

Table 7-9. Screening of nonradionuclide organic contaminants. Bold text indicates that contaminant concentration exceeded the EBSL.

Contaminant	1,1-Dichloro-ethane	1,1-Dichloro-ethylene	1,1,1-Trichloro-ethane	2-Butanone	2-Hexanone[b]	2-Methyl-naphthalene[c]	4-Methyl-2-pentanone
EBSL (mg/kg)[a]	6.95E+00	2.61E+00	4.08E+02	1.91E+01	1.91E+01	3.25E-02	NA
CFA-01							
CFA-02			1.00E-03	3.30E+00	4.50E-02	**4.70E-02**	**1.70E-02**
CFA-03							
CFA-04				2.00E-03			
CFA-05 Ditch							
CFA-05 Pond				6.10E-01	6.60E-02		**6.50E-02**
CFA-06							
CFA-08		3.00E-03					
CFA-10							
CFA-12							
CFA-13							
CFA-15							
CFA-17/47	3.60E-01		5.10E+00				
CFA-21							
CFA-23							
CFA-24							
CFA-25							
CFA-26							
CFA-27							
CFA-28							

Table 7-9. (continued).

Contaminant	1,1-Dichloro-ethane	1,1-Dichloro-ethylene	1,1,1-Trichloro-ethane	2-Butanone	2-Hexanone[b]	2-Methyl-naphthalene[c]	4-Methyl-2-pentanone
EBSL (mg/kg)[a]	6.95E+00	2.61E+00	4.08E+02	1.91E+01	1.91E+01	3.25E-02	NA
CFA-29							
CFA-30							
CFA-31							
CFA-32							
CFA-34							
CFA-37							
CFA-38							
CFA-40							
CFA-41							
CFA-43							
CFA-44							
CFA-45							
CFA-48							
CFA-49							
CFA-50							
CFA-51							

Table 7-9. (continued).

Contaminant	Acenaphthene	Acetone	Anthracene	Aroclor-1254	Aroclor-1260
EBSL (mg/kg)[a]	2.37E+01	2.78E-01	1.35E+02	1.43E-02	8.02E+00
CFA-01					
CFA-02	9.60E-02	**5.80E+00**	2.10E-01		
CFA-03					
CFA-04		1.70E-02		**2.80E+00**	
CFA-05 Ditch					
CFA-05 Pond		8.00E-02			1.47E+00
CFA-06					
CFA-08		2.30E-02		**1.30E+00**	8.80E-01
CFA-10				**1.40E+00**	1.30E+00
CFA-12				**2.10E-01**	
CFA-13				**1.00E+01**	
CFA-15					
CFA-17/47	1.20E-01	2.20E-01			
CFA-21					
CFA-23					
CFA-24					
CFA-25					
CFA-26					
CFA-27					
CFA-28					

Table 7-9. (continued).

Contaminant	Acenaphthene	Acetone	Anthracene	Aroclor-1254	Aroclor-1260
EBSL (mg/kg) [a]	2.37E+01	2.78E-01	1.35E+02	1.43E-02	8.02E+00
CFA-29					
CFA-30					
CFA-31					
CFA-32					
CFA-34					
CFA-37					
CFA-38					
CFA-40					
CFA-41					
CFA-43					
CFA-44					
CFA-45					
CFA-48					
CFA-49					
CFA-50					
CFA-51					

Table 7-9. (continued).

Contaminant EBSL (mg/kg) [a]	Benzene 5.50E+00	Benzo(a) anthracene 3.02E+00	Benzo(a) pyrene 3.34E-02	Benzo(b) fluoranthene[c] 3.25E-02	Benzo(g,h,i) perylene[c] 3.25E-02	Benzo(k) fluoranthene[c] 4.90E-02	Bis(2-ethyl hexyl)phthalate 2.63E+00	Butylbenzyl phthalate 1.43E+01
CFA-01		1.40E-01	**8.90E-01**	**2.10E-01**	**1.60E-01**	**2.00E-01**		
CFA-02	3.00E-03	6.10E-01	**5.90E-01**	**8.90E-01**	**5.20E-01**	**1.20E+00**	1.30E+00	8.80E-02
CFA-03							3.60E-02	
CFA-04							3.60E-02	
CFA-05 Ditch								
CFA-05 Pond	4.00E-03							
CFA-06								
CFA-08	4.00E-03		**4.20E-02**				1.60E+00	
CFA-10								
CFA-12			**5.90E-02**		**1.50E-01**			
CFA-13		**9.00E+00**		**4.20E+00**	**5.10E+00**	**3.20E+00**		
CFA-15								
CFA-17/47	4.80E-02		**1.37E-01**	**2.00E-01**	**1.60E-01**			
CFA-21								
CFA-23								
CFA-24								
CFA-25								
CFA-26								
CFA-27								
CFA-28								

Table 7-9. (continued).

Contaminant	Benzene	Benzo(a) anthracene	Benzo(a) pyrene	Benzo(b) fluoranthene[c]	Benzo(g,h,i) perylene[c]	Benzo(k) fluoranthene[c]	Bis(2-ethyl hexyl)phthalate	Butylbenzyl phthalate
EBSL (mg/kg)[a]	5.50E+00	3.02E+00	3.34E-02	3.25E-02	3.25E-02	4.90E-02	2.63E+00	1.43E+01
CFA-29								
CFA-30								
CFA-31								
CFA-32								
CFA-34								
CFA-37								
CFA-38								
CFA-40								
CFA-41								
CFA-43								
CFA-44								
CFA-45								
CFA-48								
CFA-49								
CFA-50								
CFA-51							2.70E-01	

Table 7-9. (continued).

Contaminant	Carbon Disulfide	Chloromethane	Chrysene	Dibenz(a,h) – anthracene[c]	Dibenzofuran	Di-n-butyl - phthalate	Di-n-octyl – phthalate
EBSL (mg/kg)[a]	5.91E-01	NA	2.27E-01	3.25E-02	NA	1.50E+01	4.73E+01
CFA-01			**4.50E+02**				
CFA-02	4.00E-03		**9.20E-01**	**3.80E-01**	**3.90E-02**	8.40E-02	
CFA-03							
CFA-04						2.90E-01	3.50E-01
CFA-05 Ditch							
CFA-05 Pond							
CFA-06							
CFA-08		**5.00E-03**				1.30E-01	
CFA-10							
CFA-12							
CFA-13			**7.90E+00**				
CFA-15							
CFA-17/47			1.60E-01				
CFA-21							
CFA-23							
CFA-24							
CFA-25							
CFA-26						4.90E-01	
CFA-27							
CFA-28							

Table 7-9. (continued).

Contaminant	Carbon Disulfide	Chloromethane	Chrysene	Dibenz(a,h) – anthracene[c]	Dibenzofuran	Di-n-butyl - phthalate	Di-n-octyl – phthalate
EBSL (mg/kg)[a]	5.91E-01	NA	2.27E-01	3.25E-02	NA	1.50E+01	4.73E+01
CFA-29							
CFA-30							
CFA-31							
CFA-32							
CFA-34							
CFA-37							
CFA-38							
CFA-40							
CFA-41							
CFA-43							
CFA-44							
CFA-45							
CFA-48							
CFA-49							
CFA-50							
CFA-51							

Table 7-9. (continued).

Contaminant	Ethylbenzene	Fluoranthene	Fluorene	Indeno(1,2,3-cd)pyrene[c]	Lindane	Methylene chloride	Naphthalene	Pentachloro – phenol
EBSL (mg/kg)[a]	2.76E+01	1.69E+01	1.69E+01	3.25E-02	NA	4.27E-01	7.17E+00	NA
CFA-01		1.00E-01		**8.30E-02**			3.80E-02	
CFA-02	1.70E-02	1.20E+00	7.90E-02	**6.50E-01**		7.40E-02	1.50E-01	**7.40E-02**
CFA-03								
CFA-04								
CFA-05 Ditch								
CFA-05 Pond						4.00E-02		
CFA-06								
CFA-08						4.00E-03	4.70E-02	
CFA-10								
CFA-12								**2.50E-01**
CFA-13				**4.60E+00**				
CFA-15		3.80E-02						
CFA-17/47	1.33E+00		1.00E-01					
CFA-21								
CFA-23								
CFA-24								
CFA-25								
CFA-26								
CFA-27	5.00E-02							
CFA-28								

Table 7-9. (continued).

Contaminant	Ethylbenzene	Fluoranthene	Fluorene	Indeno(1,2,3-cd)pyrene[c]	Lindane	Methylene chloride	Naphthalene	Pentachloro-phenol
EBSL (mg/kg)[a]	2.76E+01	1.69E+01	1.69E+01	3.25E-02	NA	4.27E-01	7.17E+00	NA
CFA-29								
CFA-30	1.00E-01							
CFA-31	7.87E-01							
CFA-32								
CFA-34								
CFA-37								
CFA-38								
CFA-40								
CFA-41								
CFA-43								
CFA-44								
CFA-45								
CFA-48								
CFA-49								
CFA-50								
CFA-51								

Table 7-9. (continued).

Contaminant	Phenanthrene	Phenol	Pyrene	Tetrachloro - ethylene	Toluene	TPH	Trichloro - ethylene	Xylene
EBSL (mg/kg)[a]	1.35E+02	6.33E+00	2.03E+01	1.62E+00	3.02E+01	5.16E+01	1.74E+01	2.78E-01
CFA-01			4.40E-01					
CFA-02	1.30E+00		2.30E+00	7.00E-03	5.10E-02			9.90E-02
CFA-03								
CFA-04					1.00E+00			
CFA-05 Ditch								
CFA-05 Pond				7.60E-02				
CFA-06								
CFA-08		1.10E+00			6.00E-03		4.00E-03	
CFA-10								
CFA-12								
CFA-13			**2.40E+01**		4.00E-03		2.10E-01	2.00E-03
CFA-15			5.90E-02					
CFA-17/47	1.40E-01		1.1E+01					6.90E+00[d]
CFA-21						**5.40E+04**		
CFA-23					9.00E+00	**1.00E+02**		
CFA-24						**2.60E+03**		
CFA-25						2.00E+01		
CFA-26		3.10E-02				**3.47E+03**		
CFA-27					6.00E-02	**1.10E+03**		1.00E-01
CFA-28						**5.74E+01**		

Table 7-9. (continued).

Contaminant	Phenanthrene	Phenol	Pyrene	Tetrachloro - ethylene	Toluene	TPH	Trichloro - ethylene	Xylene
EBSL (mg/kg)[a]	1.35E+02	6.33E+00	2.03E+01	1.62E+00	3.02E+01	5.16E+01	1.74E+01	2.78E-01
CFA-29						9.00E+00		
CFA-30						**7.60E+01**		
CFA-31					3.50E+00	**5.61E+03**		**6.69E+00**
CFA-32						3.00E+01		
CFA-34						**2.90E+02**		
CFA-37						**1.80E+02**		
CFA-38						**4.27E+02**		
CFA-40					2.00E-03	**<6.25E+02**[e]		
CFA-41						**<1.00E+03**[e]		
CFA-43								
CFA-44								
CFA-45						**<1.00E+3**[e]		
CFA-48								
CFA-49								
CFA-50								
CFA-51								

a. The minimum EBSL, in mg/kg, for all receptors/functional groups.

b. No EBSL exists for this contaminant, therefore, the EBSL for 2-butanone was used.

c. No EBSL exists for this contaminant, therefore, the EBSL for benzo(a)pyrene was used.

d. Maximum concentration from a sample collected at 10 ft. Other samples collected at 10 ft. were ≤0.094 mg/kg. Therefore, the site was eliminated.

e. Samples were screened using immunoassay, with a detection limit of 625 mg/kg at CFA-40 and a detection limit of 1,000 at CFA-41 and CFA-45.

Table 7-10. Screening of radionuclide contaminants. Bold text indicates contaminant concentration exceeded background and the EBSL.

Contaminant Background (pCi/g) EBSL (pCi/g)[a]	Ag-108m NA 1.83E+03	Am-241 1.90E-02 1.78E+01	Ba-133 NA 7.34E+03	Bi-212 NA 1.23E+03	Bi-214 NA 1.94E+03	Co-60 NA 1.18E+03	Cs-134 NA 1.90E+03	Cs-137 1.28E+00 4.95E+03	Eu-152 NA 2.18E+03
CFA-01						1.00E-01		8.80E-01	
CFA-02									
CFA-03								3.07E-01	
CFA-04								2.00E-00	
CFA-05[b]		2.72E+00		1.72E+00	1.37E+00				
CFA-06									
CFA-08		1.40E-01				2.41E-01		1.80E+02	4.60E-01
CFA-10									
CFA-12	2.46E+00	2.37E+01	7.70E-01			2.90E+00	9.40E-01	1.07E+03	1.06E+01
CFA-13		9.40E+00				7.99E-02		9.88E-01	
CFA-15		1.38E-02							
CFA-17/47									
CFA-21									
CFA-23									
CFA-24									
CFA-25									
CFA-26									
CFA-27									
CFA-28									

Table 7-10. (continued).

Contaminant	Ag-108m	Am-241	Ba-133	Bi-212	Bi-214	Co-60	Cs-134	Cs-137	Eu-152
Background (pCi/g)	NA	1.90E-02	NA	NA	NA	NA	NA	1.28E+00	NA
EBSL (pCi/g)[a]	1.83E+03	1.78E+01	7.34E+03	1.23E+03	1.94E+03	1.18E+03	1.90E+03	4.95E+03	2.18E+03
CFA-29									
CFA-30									
CFA-31									
CFA-32									
CFA-34									
CFA-37									
CFA-38									
CFA-40									
CFA-41									
CFA-43									
CFA-45									
CFA-48									
CFA-49						3.90E-02			
CFA-50									
CFA-51								1.10E-01	

Table 7-10. (continued).

Contaminant	Eu-154	K-40	Mn-54	Pb-212	Pb-214	Pa-234m	Pu-238	Pu-239	Ra-226
Background (pCi/g)	NA	NA	NA	NA	NA	NA	9.10E-03	1.90E-01	NA
EBSL[a] (pCi/g)	2.48E+03	NA	3.53E+03	1.45E+04	6.78E+03	2.37E+03	1.78E+01	1.89E+01	2.04E+01
CFA-01									
CFA-02									
CFA-03									
CFA-04						5.30E-01			4.15E+00
CFA-05[b]		1.90E+00		1.50E+00	1.38E+00			4.29E+00	2.93E+00[c]
CFA-06									
CFA-08	1.10E+00		7.52E-02				2.00E+00	2.90E+00	5.71E+00
CFA-10									
CFA-12	7.30E-01						1.01E+00	6.00E-02	
CFA-13								4.54E-03	3.37E+00
CFA-15									2.54E+00
CFA-17/47									
CFA-21									
CFA-23									
CFA-24									
CFA-25									
CFA-26									
CFA-27									
CFA-28									

Table 7-10. (continued).

Contaminant	Eu-154	K-40	Mn-54	Pb-212	Pb-214	Pa-234m	Pu-238	Pu-239	Ra-226
Background (pCi/g)	NA	NA	NA	NA	NA	NA	9.10E-03	1.90E-01	NA
EBSL[a] (pCi/g)	2.48E+03	NA	3.53E+03	1.45E+04	6.78E+03	2.37E+03	1.78E+01	1.89E+01	2.04E+01
CFA-29									
CFA-30									
CFA-31									
CFA-32									
CFA-34									
CFA-37									
CFA-38									
CFA-40									
CFA-41									
CFA-43									
CFA-45									
CFA-48									
CFA-49									1.83E+00
CFA-50									
CFA-51									

Table 7-10. (continued).

Contaminant Background (pCi/g)	Sr-90 7.60E-01	Th-234 NA	Tl-208 NA	U-234 1.95E-00	U-235 NA	U-238 1.85E-00	Zn-65 NA	Zr-95 NA
EBSL[a] (pCi/g)	3.34E+03	4.16E+04	NA	2.05E+01	2.27E+01	2.32E+01	5.21E+03	3.69E+03
CFA-01								
CFA-02								
CFA-03								
CFA-04	6.30E+00	4.80E-01		5.84E+00[b]	1.61E+00	9.43E+00[b]		
CFA-05[b]			1.41E+00					
CFA-05								
CFA-06								
CFA-08	1.67E+01			2.80E+00	4.40E-01	1.80E+00		1.01E-01
CFA-10								
CFA-12	2.40E+00			2.56E+01	2.40E+00	1.82E+01	8.00E-02	
CFA-13	1.99E-01			2.34E+00	5.52E-01	2.53E+00	1.53E-01	
CFA-15	1.66E-01			1.01E+00	6.31E-02	9.67E-01	1.40E-01	
CFA-17/47								
CFA-21								
CFA-23								
CFA-24								
CFA-25								
CFA-26								
CFA-27								
CFA-28								

Table 7-10. (continued).

Contaminant	Sr-90	Th-234	Tl-208	U-234	U-235	U-238	Zn-65	Zr-95
Background (pCi/g)	7.60E-01	NA	NA	1.95E-00	NA	1.85E-00	NA	NA
EBSL[a] (pCi/g)	3.34E+03	4.16E+04	NA	2.05E+01	2.27E+01	2.32E+01	5.21E+03	3.69E+03
CFA-29								
CFA-30								
CFA-31								
CFA-32								
CFA-34								
CFA-37								
CFA-38								
CFA-40								
CFA-41								
CFA-43								
CFA-45								
CFA-48								
CFA-49								
CFA-50								
CFA-51								

a. The minimum EBSL for all receptors/functional groups.

b. Reflects the maximum concentration of the ditch and the main pond.

c. The 95% UCL of the arithmetic mean was used to estimate exposure-point concentrations. It is acceptable to screen the EBSL against the UCL.

considered in the human health risk assessment, the concentrations generally came from Track 1 and Track 2 Decision Documents; in these cases, it is assumed that maximum concentrations were used in the documents, though this is not always the case. Blank cells in the tables indicate that the contaminant was either not sampled or not detected at the site.

The stepwise decision process for inclusion of a contaminant in the WAG ERA was:

1. If the site concentration of the contaminant (usually the maximum) does not exceed the 95/95% upper tolerance limit (UTL) for background concentrations, then the contaminant will not be considered in the ERA for that site.

2. If the site concentration of the contaminant does not exceed the EBSL concentration, then the contaminant will not be considered in the WAG ERA for that site.

3. As with the human health it is appropriate to screen six inorganic constituents which are not associated with toxicity under normal circumstances. These include aluminum, calcium, magnesium, potassium, iron, and sodium. These will be eliminated if the concentrations is less than 10x background.

4. Otherwise, the contaminant is included in the WAG ERA for the site.

7.2.6.2 Summary of Screening Process. The 29 sites retained in the OU 4-13 ERA are summarized in Table 7-11. Thirteen sites were retained for TPH contamination (CFA-21, CFA-23, CFA-24, CFA-26, CFA-27, CFA-28, CFA-30, CFA-34, CFA-37, CFA-38, CFA-40, and CFA-41 and CFA-45). Six sites were retained for metals (CFA-06, CFA-15, CFA-43, CFA-44, CFA-48, and CFA-51). Two sites were retained for PCBs & metals (CFA-04 and CFA-10). Three sites were retained for metals and organic compounds (CFA-01, CFA-02, and CFA-05). Two sites were retained for PCBs, metals and organic compounds (CFA-08 and CFA-13). Two sites were retained for organic compounds (CFA-12 and CFA-17/47). One site was retained for TPH and an organic compound (CFA-31). No sites were retained for radiological contaminants. Sites for which all contaminants have been eliminated during the screening process will not be considered in the WAG 4 ERA.

7.2.7 Pathways of Contaminant Migration and Exposure

The potential risk posed by contaminants in surface and subsurface soil and surface water for WAG 4 sites of concern was considered in this assessment.

7.2.7.1 Surface Soil. Contaminated surface soil represents the major source of possible contaminant exposure for WAG 4 ecological components. Surface soil, as defined for use in the INEEL WAG ERAs, includes the uppermost 15 cm (0.5 ft). Many of the WAG 4 sites of concern represent sources of surface soil contamination resulting from past contamination.

The ecological pathways/exposure model for WAG 4 contaminated surface soil is shown on Figure 7-4. This model depicts the following mechanisms for surface soil transport of contaminants:

- Wind and water erosion
- Leaching and infiltration
- Plant uptake

Table 7-11. Site and COPC retention table for the WAG 4 ecological risk assessment.

OU	Site	Retained in Human Health Assessment	Reason Retained for Further Assessment[a]	Eliminated as a Concern in the ERA[a]	COPCs[b]
Sites included in the human health risk assessment					
4-02	CFA-13	Yes	C		Antimony, Aroclor-1254, arsenic, BaA, BbF, B(g,h,i)P, BkF, cadmium, chromium, chrysene, copper, I(1,2,3cd)P, lead, mercury, nickel, pyrene, selenium, silver, and zinc
	CFA-15	Yes	C		Copper and mercury
4-05	CFA-04	Yes	C	R	Aroclor-1254, arsenic, barium, cadmium, chromium, cobalt, copper, lead, mercury, nickel, nitrate, silver, and vanadium
	CFA-06	Yes	C		Arsenic and lead
	CFA-17/47	Yes	C		BaP, BbF, B(g,h,i)P
4-07	CFA-12	Yes	C	R	PCP
4-08	CFA-08	Yes	C	R	Aroclor-1254, arsenic, BaP, barium, cadmium, chloromethane, chromium, copper, lead, mercury, nickel, selenium, and silver
4-09	CFA-10	Yes	C		Antimony, Aroclor-1254, arsenic, cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel, and zinc
	CFA-26	Yes	C		TPH
4-11	CFA-05 Ditch	Yes	C	R	Arsenic, barium, cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel, vanadium, and zinc
	CFA-05 Pond	Yes	C	R	4-methyl-2-pentanone, arsenic, cadmium, chromium, copper, lead, maganese, and zinc
Sites not included in the human health risk assessment					
4-03	CFA-21	No	C		TPH
	CFA-23	No	C		TPH
	CFA-24	No	C		TPH
	CFA-25	No		C	
	CFA-27	No	C		TPH
	CFA-28	No	C		TPH

Table 7-11. (continued).

OU	Site	Retained in Human Health Assessment	Reason Retained for Further Assessment[a]	Eliminated as a Concern in the ERA[a]	COPCs[b]
	CFA-29	No		C	
	CFA-30	No	C		TPH
	CFA-31	No	C		TPH and xylene
	CFA-32	No		C	
	CFA-34	No	C		TPH
	CFA-37	No	C		TPH
	CFA-38	No	C		TPH
	CFA-45	No	C		TPH
4-04	CFA-40	No	C		TPH
	CFA-41	No	C		TPH
4-05	CFA-50	No		C	
4-06	CFA-43	No	C		Lead
	CFA-44	No	C		Lead
4-07	CFA-48	No	C		Lead and mercury
4-08	CFA-49	No		R	
4-12	CFA-01	No	C		BaP, BbF, B(g,h,i), BkF, chromium, chrysene, copper, I(1,2,3-cd)P, lead, silver, and zinc
	CFA-02	No	C		2-methynaphthalene, 4-methyl-2-pentanone, acetone, arsenic, BaP, BbF, B(g,h,i)P, BkF, chrysene, D(a,h)A, dibenzofuran, I(1,2,3-cd)P, lead, mercury, and PCP
4-13	CFA-51	No	C	R	Cadmium, copper, lead, selenium, and zinc

a. R = radionuclides; C = nonradiological chemicals.

b. Aroclor-1254 = PCB (polychlorinated biphenol); BaP = benzo(a)pyrene; BbF = benzo(b)fluoranthene; B(g,h,i)P = benzo(g,h,i) perylene; BkF = benzo(k)fluoranthene; D(a,h)A = dibenz(a,h)anthracene; I(1,2,3-cd)P = indeno(1,2,3-cd)pyrene; PCP = pentachlorophenol; TPH = total petroleum hydrocarbons

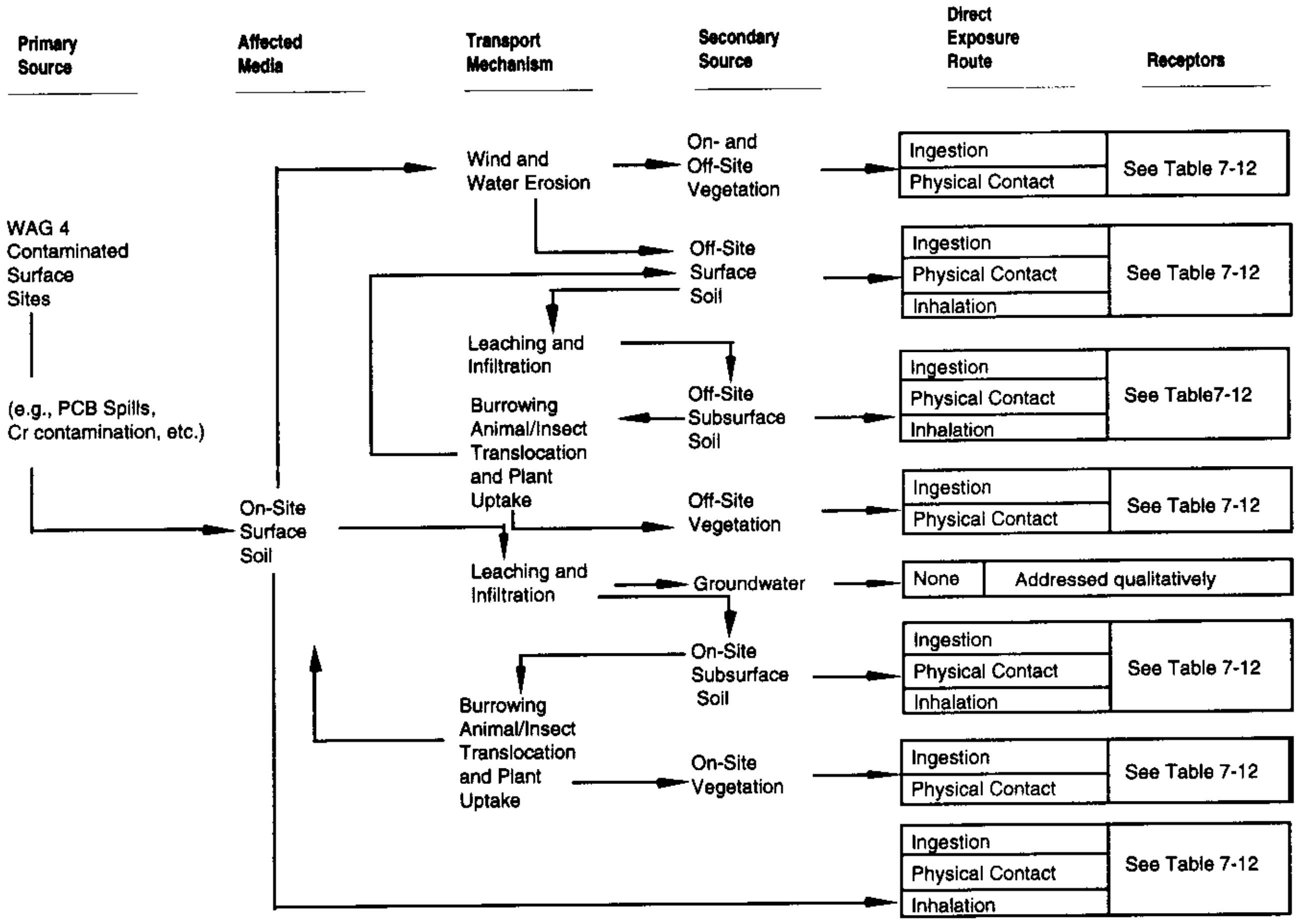

Figure 7-4. Ecological pathways/exposure model for WAG 4 surface contamination.

- Burrowing animal translocation.

Transportation of contaminated soils through these mechanisms may result in contamination of various other media or secondary sources, including the following onsite and offsite sources:

- Surface water
- Surface soil
- Subsurface soil
- Vegetation.

Receptors having potential for direct exposure to WAG 4 surface soils are presented in Table 7-12. Ecological receptors can be exposed to contaminated media directly through ingestion of contaminated vegetation, water, and prey; incidental ingestion of soil; or through physical contact or inhalation. Inhalation and physical contact, however, are considered to play minor roles in the exposure to surface contamination for WAG 4 and are not evaluated in this assessment. The functional groups identified as having direct exposure include most terrestrial avian, mammalian, reptilian, and insect species potentially present in the WAG 4 area.

7.2.7.2 Subsurface Soil. The ecological pathways/exposure model for WAG 4 contaminated subsurface soil is presented on Figure 7-5. Many of the WAG 4 sites of concern are contaminated subsurface soil sites resulting from buried contaminated soil or sediments, leaking underground storage tanks, and past surface spills followed by leaching. For the WAG ERA analysis, subsurface soil is defined between 15 cm and 3 m (0.5 to 10 ft). Contaminants in subsurface soil can be transported to ecological receptors by plant uptake and translocation by burrowing animals. Contamination at depths greater than 3 m (10 ft) below the surface are considered inaccessible to ecological receptors, since this is generally below the root zone of plants and the burrowing depth of ground-dwelling animals.

Once contaminated soil is brought close to the surface, transport and exposure scenarios for ecological receptors are the same as for surface soil. For subsurface contamination, inhalation and direct contact (by burrowing animals) are likely more important exposure routes than for surface contamination.

Receptors having potential for direct exposure to WAG 4 subsurface soil contamination include animals dwelling below ground and deep rooting plants (see Table 7-12). Because subsurface soil contamination may be translocated to the surface by plant uptake and burrowing animals, other terrestrial species also have some potential for exposure through this pathway.

7.2.7.3 Surface Water. Surface water flow and accumulation in and around WAG 4 are generally limited to spring runoff and intense precipitation events and no major natural drainages occur at WAG 4. WAG 4 surface flows are limited to localized runoff, particularly from paved areas of the existing facilities. None of the sites of concern evaluated in this ERA have standing surface water and no pathway to ecological receptors exists for groundwater at WAG 4. Consequently, these pathways were not evaluated as part of the assessment.

Table 7-12. Summary of WAG 4 exposure media and ingestion route for INEEL functional groups.

Receptor	Surface Soils	Subsurface Soils	Vegetation	Sediments	Prey Consumption: Invertebrates	Prey Consumption: Mammals	Prey Consumption: Birds
Avian herbivores (AV122)	x		x				
Avian insectivores (AV210A)				x	x		
Avian insectivores (AV222)	x				x		
Avian insectivores (AV232)				x	x		
Avian carnivores (AV310)X	x					x	x
Northern goshawk	x					x	x
Peregrine falcon	x					x	
Avian carnivores (AV322)X						x	
Bald eagle						x	
Ferruginous hawk						x	
Loggerhead shrike						x	x
Avian carnivores (AV322A)X Burrowing owl	x	x			x	x	
Avian omnivores (AV422)			x		x	x	x
Mammalian herbivores (M122)	x		x				
Mammalian herbivores (M122A)X	x	x	x				
Pygmy rabbit	x	x	x				
Mammalian insectivores (M210A)X	x				x		
Townsend's western big-eared bat	x				x		
Small-footed myotis	x				x		
Long-eared myotis					x		
Mammalian insectivores (M222)	x			x	x		
Mammalian carnivore (M322)	x					x	
Mammalian omnivores (M422)	x	x	x		x		
Reptilian insectivores (R222)—Sagebrush lizard	x				x		
Reptilian carnivores (R322)	x					x	
Plants-uptake							

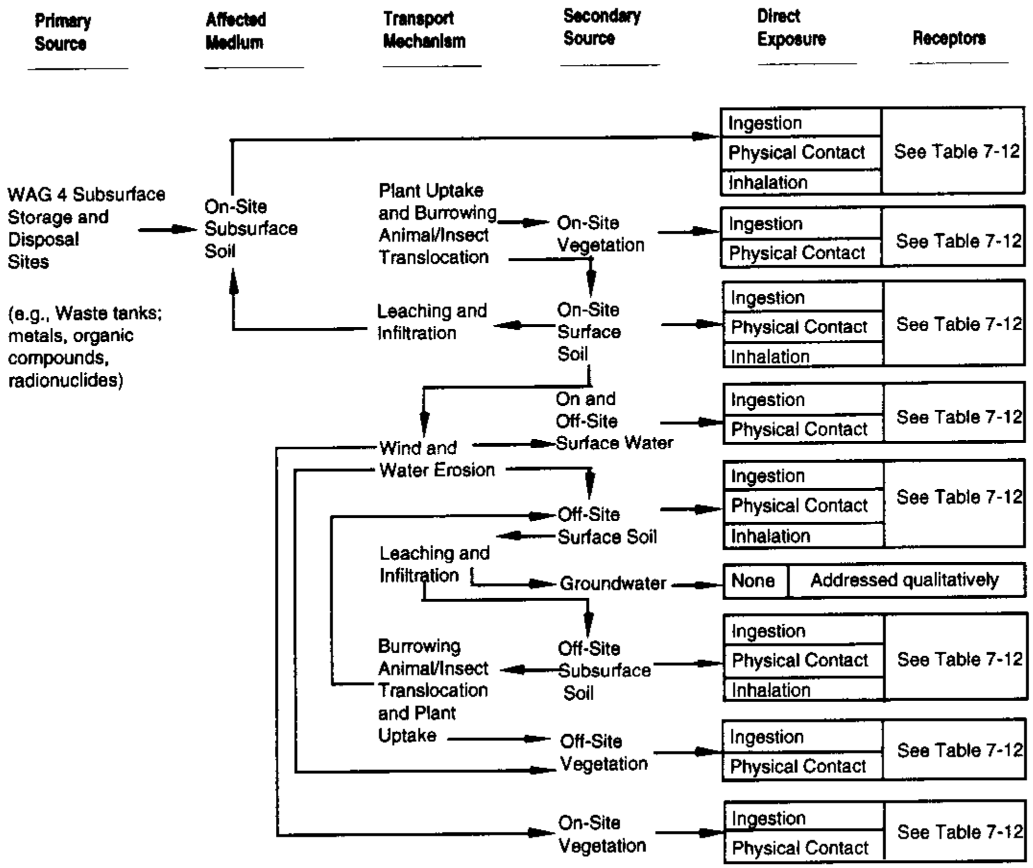

Figure 7-5. Ecological pathways/exposure model for WAG 4 subsurface storage and disposal sites.

7.2.8 Conceptual Site Model

The pathways/exposure models for surface soil, subsurface soil, and surface water were integrated to produce the WAG 4 CSM shown on Figure 7-6. This model reflects both direct (previous sections) and indirect (i.e., predation) receptor exposure pathways for WAG 4 COPCs.

7.2.9 Development of Assessment Endpoints

Assessment endpoints are "formal expressions of the actual environmental values that are to be protected" (Suter 1989). Assessment endpoints developed for this WAG ERA are presented on Table 7-13. The endpoints were developed around the protection of INEEL biota represented by functional groups and individual T/E and sensitive species known to exist at WAG 4 and identified as having the potential for exposure to COPCs. Each T/E and sensitive species with the potential for exposure is addressed individually in the risk analysis, whereas potential effects to other receptors of concern are dealt with at the functional group level. Assessment endpoints defined for the WAG 4 ERA reflect OU 10-04 hazard/policy goals discussed in the Guidance Manual (VanHorn et al. 1995) and incorporate the suggested criteria for developing assessment endpoints, including ecological relevance and policy goals (EPA 1992; Suter 1993).

These assessment endpoints are the focus for WAG ERA risk characterization and link the measurement endpoints to the WAG ERA goals. The primary objective of this WAG ERA is to identify COPCs and levels of those contaminants that represent potential risk to WAG 4 ecological components. Consequently, toxic effects to ecological components as a result of exposure to COPCs were considered a primary concern for WAG 4 biota. Although adverse effects due to physical stressors are also of concern in evaluating potential risks to INEEL ecological components, these effects are not addressed by the WAG ERA. This was used to establish the potential for contaminants to contribute to ecological risk to WAG 4 individuals and populations. The HQ is used to indicate whether or not a potential for adverse effects exists. The use of the HQ as an indicator of effects is discussed in detail in Section 7.4.1.

7.2.10 Measurement Endpoint Selection

This section describes the selection of measurement endpoints for the WAG ERA. Measurement endpoints are measurable responses of ecological receptors to contaminants that can be related to ERA assessment endpoints. For this ERA, WAG 4 ecological components (i.e., flora and fauna) were not measured or surveyed directly. Rather, published references were used as the primary sources of ecological and toxicological data from which measurement endpoints were derived. Values extracted from these references were used to calculate dose for all ecological receptors and to develop toxicity reference values (TRVs) for contaminants.

Table 7-14 summarizes the WAG 4 ERA assessment endpoints. It also contains published values for species' dietary habits, home ranges, site use, exposure duration (ED), soil ingestion, food digestion, and body weights for the representative species. Quantified critical exposure levels (QCELs) and adjustment factors (AFs) were constructed from the literature to develop appropriate TRVs for receptors associated with WAG 4 contaminant pathways. Criteria for development of these TRVs are discussed in Section 7.4.1. In general, the criteria incorporate the requirements for appropriate endpoints, including relevance to an assessment endpoint, applicability to the route of exposure, use of existing data, and consideration of scale (VanHorn et al. 1995).

The exposure-point concentrations of contaminants in each medium were used to calculate dose for each affected receptor.

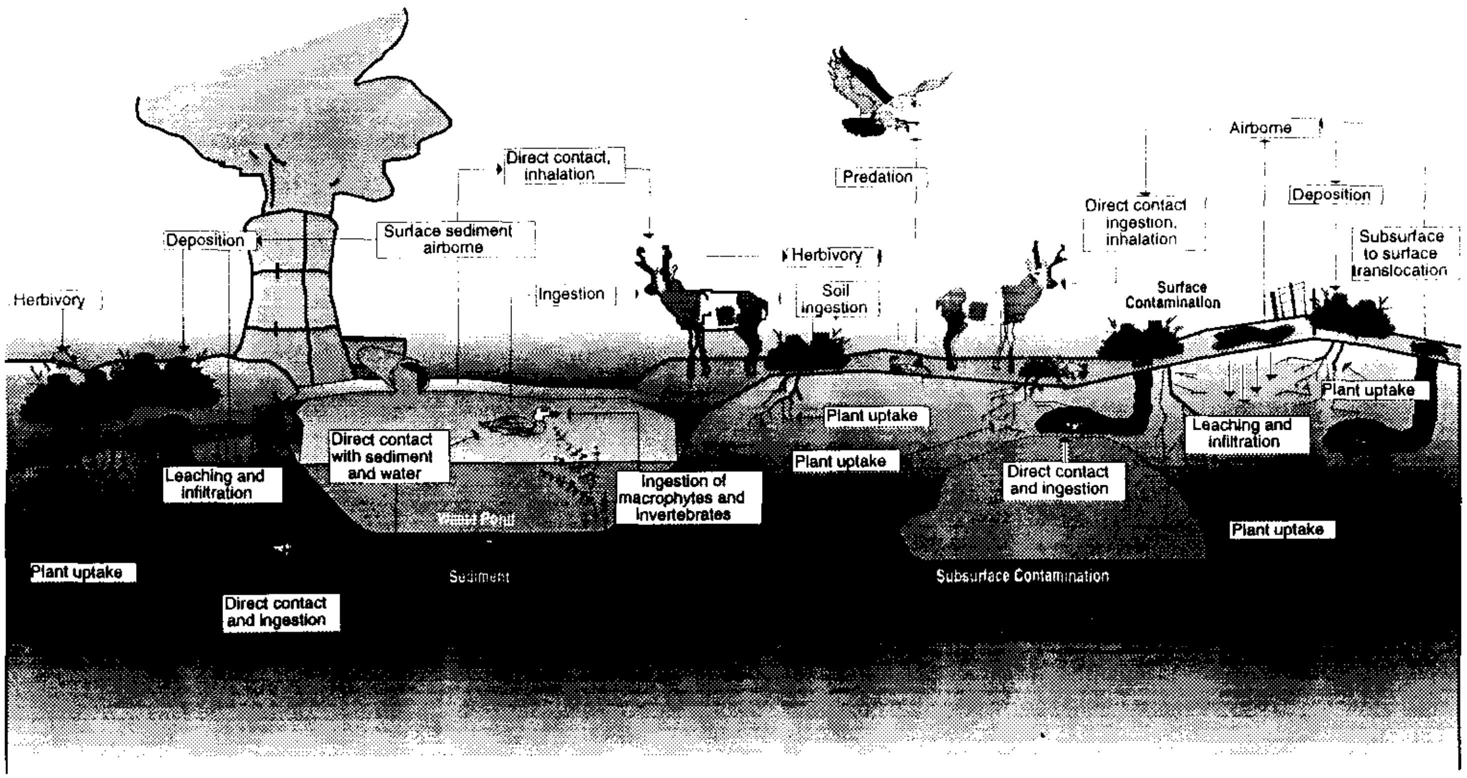

Figure 7-6. WAG 4 ecological conceptual site model.

Table 7-13. Summary of management goals, assessment endpoints and indicators of risk for WAG 4 ERA.

Management Goal	WAG Assessment Endpoint	Indicator of Risk[a]
Maintain INEEL T/E individuals and populations by limiting exposure to organic, inorganic, and radionuclide contamination.	Indication of possible effects (risk) to T/E individuals and populations as a result of contaminant exposure: peregrine falcon, northern goshawk, bald eagle, burrowing owl, ferruginous hawk, loggerhead shrike, pygmy rabbit, Townsend=s western big-eared bat, long-eared myotis, small-footed myotis, sagebrush lizard, and individuals and populations (Functional Groups AV310, AV322, AV322A, AV233, AV210, R222, M123 and M210A).	HQ[b] ≥ target value
Maintain INEEL T/E individuals and populations by limiting exposure to physical stressors.	Not addressed by WAG ERA.	N/A
Maintain survival, abundance and diversity of INEEL native biota by limiting exposure to organic, inorganic, and radionuclide contamination.	Indication of possible effects to WAG native vegetation communities as a result of contaminant exposure.	HQ ≥ target value
	Indication of possible effects (risk) to WAG wildlife populations as a result of contaminant exposure (represented by Functional Groups identified in the site conceptual model: invertebrates, waterfowl, small mammals, large mammals, song birds, raptors, top predators).	HQ ≥ target value
Maintain survival, abundance and diversity of INEEL native biota by limiting exposure to physical stressors.	Not addressed by WAG ERA.	N/A

Source: Suter 1993

a. Based on original guidance provided by EPA (1994), this column might have been called the Ameasurement endpoint.≅ Subsequent guidance from EPA (1996) now discusses measures/indicators of effects.

b. HQ = hazard quotient. The target value is 1 for nonradionuclide contaminants and 0.1 for radionuclide contaminants. The HQ approach does not consider variability and uncertainty in either exposure or toxicity estimates, and therefore does not represent a statistical probability of occurrence of adverse ecological effects. HQs provide essentially a Ayes or no≅ determination of risk and are therefore well-suited for screening-level assessments (EPA 1988b). A limitation of the quotient method is that it does not predict the degree of risk or magnitude of effects associated with specified levels of contamination (EPA 1988b).

Table 7-14. Summary of WAG 4 Ecological Risk Assessment endpoints.

WAG 4 Assessment Endpoint	Ecological component	Functional Group (other groups represented)	Measurement Species (TRV test species)
Indication of risk to T/E individuals and populations as a result of contaminant exposure.	Pygmy rabbit	M122A (M123)	Rate, mouse/meadow vole (M122A), deer mouse
	Peregrine falcon, northern goshawk	AV310	Chicken, goshawk (AV310), American Kestrel/red-tailed hawk (AV322)
	Ferruginous hawk, loggerhead shrike, bald eagle, burrowing owl	AV322, AV322A	Chicken, goshawk (AV310), American kestrel/red-tailed hawk (AV322)
	Townsend's western big-eared bat, long-eared myotis, small-footed myotis	M210A (M210)	None located
	Sagebrush lizard	R222	None located
Indication of possible effects to WAG 4 native vegetation communities as a result of contaminant exposure.	Vegetation	Sagebrush, bunchgrass	Bush beans, crop plants
Indication of possible effects to WAG 4 wildlife populations as a result of contaminant exposure (represented by functional groups identified in the site conceptual mode: small mammal, large mammals, song birds, raptors, top predators, invertebrates)	Small mammals	M422, M122A (M222, M123)	Rat, mouse/meadow vole (M122A), deer mouse (M422)
	Mammalian carnivore/omnivores	M422A, M322	Rat, mouse, dog, cat, mink/fox
	Mammalian herbivores	M122 (M121)	Rat, mouse, mule deer/pronghorn (M122)
	Mammalian insectivore	M210A, M222 (M210)	Western racer
	Avian carnivores	AV322, AV310	Goshawk (AV310), American kestrel/red-tailed hawk (AV322)
	Avian herbivores	AV122 (AV121)	Chicken, pheasant, quail, passerines/sharp-tailed and ruffed grouse
	Avian insectivores	AV210A, AV222, AV232 (AV210, AV221)	Chicken, pheasant, quail, passerines/American robin (AV222), cliff swallow (AV210A)
	Reptiles	R222, R322	Western racer/None located
	Invertebrates	Phytophagous, saprophagous, entomophagous	Unidentified

The measurement endpoints are the modeled dose as compared to the TRVs for each contaminant for each receptor functional group. The modeled dose was divided by the TRV to produce an HQ for each contaminant and receptor of concern. The HQ is ultimately used to measure whether the assessment endpoints have been attained, that is, survival and reproductive success are ensured for the receptor groups being assessed (HQs are less than the target value for all receptors for each contaminant).

7.3 Analysis

The risk analysis step of the WAG 4 ERA involves assessing exposure to contaminants (characterization of exposure) and potential effects of exposure (characterization of effects). These activities are conducted interactively to ensure that the methods used to assess exposure and effects are compatible. Assessing exposure and effects is based on the ecological endpoints and conceptual models derived during the problem formulation presentation.

A primary step in analyzing risk is to determine the potential for site-related contaminants to increase the incidence of adverse effects in exposed populations. The objective of this activity is to estimate the magnitude, frequency, duration, and route of exposure to site-related contaminants by ecological receptors. Accomplishing this task involves completing the following steps:

1. Discuss the factors that influence contaminant fate and transport.

2. Estimate dose for all functional groups and contaminants.

7.3.1 Contaminant Fate and Transport

No formal transport and fate modeling was conducted for this WAG ERA. Environmental fate properties are important because they provide information on the environmental behavior of contaminant compounds throughout various environmental media. WAG 4 surface and subsurface soil contaminants, identified in Section 7.2.6 include the following:

- 2-methylnaphthalene
- 4-methyl-2-pentanone
- acetone
- antimony
- Aroclor-1254
- arsenic
- barium
- benzo(a)anthracene
- benzo(a)pyrene
- benzo(b)fluoranthene
- benzo(g,h,i)perylene
- benzo(k)fluoranthene
- cadmium
- chloromethane
- chromium III
- chrysene
- cobalt
- copper
- dibenz(a,h)anthracene
- dibenzofuran
- indeno(1,2,3-cd)pyrene
- lead
- manganese
- mercury
- nickel
- nitrate
- pentachlorophenol

- pyrene
- selenium
- silver
- sulfate
- thallium
- TPH
- xylene
- zinc

Many of the inorganic contaminants are metals. Soils represent the most concentrated source of metals in the terrestrial environment. The health risks posed by trace metals in soils are not determined solely by their quantity. A number of contaminant, environmental, and biological conditions and processes influence the accessibility and availability of metals to organisms, and hence their toxicological significance. First, speciation is a major determinant of the fate, bioavailability, absorption, and toxicologic characteristics of metal compounds. Second, the distribution coefficient between soil and water (K_d) depends upon both the properties of the metal and the composition of the soil. This coefficient also governs the bioavailability of a metal to organisms contacting the soil, with the weakly bound metals highly bioavailable and the strongly bound metals less bioavailable. Other influential factors include: (1) the characteristics of the interface (e.g., lung, skin, intestine), (2) the reactivity of the metal with the interface, and (3) the concurrent presence of other metals or other substances that may stimulate or inhibit metal uptake. Factors that influence the fate and transport (and thereby bioavailability) of the WAG 4 COPCs are presented in Sections 7.3.4 through 7.3.6, along with discussions of the ecotoxicological effects for these contaminants.

7.3.2 Determining Exposure

Potential exposures for functional group, T/E, and sensitive species were determined based on site-specific life history and feeding habits, when possible. Quantification of group and individual exposures incorporated species-specific numerical exposure factors including body weight, ingestion rate, and fraction of diet composed of vegetation or prey, and soil consumed from the affected area. Parameters used to model contaminant intakes by the functional groups are presented in Table 7-15. These values were derived from a combination of parameters that produced the most conservative overall exposure for the group. The functional group parameters (see Table 7-15) represent the most conservative combination of percent prey, percent vegetation, percent soil, ED, ingestion rate, body weight, and home ranges from species within the functional group.

Each receptor's diet was assumed to be composed of percentages of two food types (i.e., percentages of either prey or vegetation) to simplify exposure calculations. For example, herbivorous animals are assumed to consume solely vegetation taken from the WAG 4 area (i.e., 100% of the vegetation consumed by herbivores comes from WAG 4). While this is a simplistic and conservative assumption, breaking down the diet of individual species within a functional group in more detail, while warranted, is beyond the scope of a WAG ERA. Most terrestrial receptors incidentally or directly ingest soil, and the percent of soil ingested from that affected area was also estimated. Insectivores are very conservatively modeled because of the complexity of contaminant intake from insects to insectivores, and inadequate data. Therefore, the method used for estimating contaminant concentrations in insect prey poses large uncertainty.

Exposure estimates were corrected for the WAG 4 site areas by the use of SUFs. The SUF is the WAG 4 site area (ha) divided by the species' home range (ha) to a maximum of 1. The SUF is the proportion of the site area to the home range and is not allowed to be greater than 1 (i.e., the animal can use no more than 100% of the site area). Home ranges for the functional groups and species of concern at WAG 4 are summarized in Table 7-15. A SUF of less than 1 indicates that the home range is larger than

Table 7-15. WAG 4 species parameters.

Functional groups	PP[a]	PV[b]	PS[c]	ED[d]	IR[e] (kg/day)	Nagy equation	BW[f] (kg)	HR[g] (Ha)	WI[h]
Avian herbivores (AV122)	0.00E+01	9.07E-01	9.30E-02	1.00E-00	1.46E-03	all birds	3.50E-03	5.18E-00	1.33E-03
Avian insectivores (AV210)	9.80E-01	0.00E+01	2.00E-02	6.50E-01	2.90E-03	all birds	1.00E-02	8.38E-00	2.70E-03
Avian insectivores (AV210A)	9.70E-01	0.00E+01	3.00E-02	6.50E-01	3.89E-03	passerines	1.46E-02	2.39E-00	3.48E-03
Avian insectivores (AV222)	9.07E-01	0.00E+01	9.30E-02	1.00E-00	3.07E-03	all birds	1.09E-02	3.80E-01	2.86E-03
Avian carnivores (AV310)	9.80E-01	0.00E+01	2.00E-02	1.00E-00	1.61E-02	all birds	1.39E-01	2.18E+02	1.57E-02
Northern goshawk	9.80E-01	0.00E+01	2.00E-02	2.50E-01	6.00E-02	all birds	1.05E-00	2.13E+02	6.10E-02
Peregrine falcon	9.80E-01	0.00E+01	2.00E-02	2.50E-01	4.96E-02	all birds	7.82E-01	3.31E+01	5.00E-02
Avian carnivores (AV322)	9.80E-01	0.00E+01	2.00E-02	1.00E-00	7.44E-03	all birds	4.25E-02	9.00E-00	7.11E-03
Bald eagle	9.80E-01	0.00E+01	2.00E-02	2.50E-01	1.60E-01	all birds	4.74E-00	4.94E+02	1.67E-01
Ferruginous hawk	9.80E-01	0.00E+01	2.00E-02	6.50E-01	6.19E-02	all birds	1.10E-00	5.60E+02	6.29E-02
Loggerhead shrike	9.80E-01	0.00E+01	2.00E-02	6.50E-01	7.44E-03	all birds	4.25E-02	4.57E-00	7.11E-03
Avian carnivores (AV322A)	9.70E-01	0.00E+01	3.00E-02	2.50E-01	1.73E-02	all birds	1.55E-01	1.00E+01	1.69E-02
Burrowing owl	9.70E-01	0.00E+01	3.00E-02	2.50E-01	1.73E-02	all birds	1.55E-01	1.00E+01	1.69E-02
Avian omnivores (AV422)	6.27E-01	2.80E-01	9.30E-02	1.00E-00	1.13E-02	all birds	8.02E-02	1.10E+01	1.09E-02
Mammalian herbivores (M121)	0.00E+01	9.80E-01	2.00E-02	2.50E-01	3.14E-01	mammal herbivore	5.80E-00	1.10E+01	4.82E-01
Mammalian herbivores (M122)	0.00E+01	9.37E-01	6.30E-02	1.00E-00	3.30E-03	mammal herbivore	1.10E-02	2.30E-01	1.71E-03
Mammalian herbivores (M122A)	0.00E+01	9.23E-01	7.70E-02	1.00E-00	4.27E-03	mammal herbivore	1.57E-02	3.00E-01	2.35E-03
Pygmy rabbit	0.00E+01	9.80E-01	2.00E-02	1.00E-00	4.53E-02	mammal herbivore	4.04E-01	2.80E-01	4.38E-02
Mammalian insectivores (M210)	9.80E-01	0.00E+01	2.00E-02	2.50E-01	2.11E-03	rodents	9.03E-03	2.39E-00	1.43E-03
Mammalian insectivores (M210A)	9.80E-01	0.00E+01	2.00E-02	1.00E-00	1.43E-03	rodents	4.65E-03	2.39E-00	7.88E-04
Townsend's Western big-eared bat	9.90E-01	0.00E+01	1.00E-02	1.00E-00	2.37E-03	rodents	1.10E-02	2.39E-00	1.71E-03
Small-footed myotis	9.90E-01	0.00E+01	1.00E-02	1.00E-00	1.44E-03	rodents	4.69E-03	2.39E-00	7.94E-04
Long-eared myotis	9.90E-01	-1.00E-02	2.00E-02	1.00E-00	1.77E-03	rodents	6.65E-03	2.39E-00	1.09E-03
Mammalian insectivores (M222)	9.76E-01	0.00E+01	2.40E-02	1.00E-00	1.66E-03	rodents	6.00E-03	1.24E-01	9.91E-04
Mammalian carnivores (M322)	9.23E-01	0.00E+01	7.70E-02	1.00E-00	1.66E-02	all mammals	1.78E-01	1.30E+01	2.09E-02
Mammalian omnivores (M422)	8.04E-01	1.00E-01	9.40E-02	1.00E-00	3.06E-03	rodents	1.70E-02	7.20E-01	2.53E-03
Reptilian insectivores (R222)	9.76E-01	0.00E+01	2.40E-02	1.00E-00	5.60E-05	reptile insectivores	6.61E-03	1.17E-01	0.00E+01

Table 7-15. (continued).

Functional groups	PP[a]	PV[b]	PS[c]	ED[d]	IR[e] (kg/day)	Nagy equation	BW[f] (kg)	HR[g] (Ha)	WI[h]
Sagebrush lizard	9.76E-01	0.00E+01	2.40E-02	1.00E-00	5.60E-05	reptile insectivores	6.61E-03	1.17E-01	0.00E+01
Reptilian carnivores (R322)	9.52E-01	0.00E+01	4.80E-02	1.00E-00	6.80E-03	literature value[i]	1.50E-02	3.00E-00	0.00E+01
Plants	0.00E+01	0.00E+01	1.00E-00	1.00E-00					

a. PP = percentage of diet represented by prey ingested (unitless). Herbivores = 0% prey, total PV = PV-PS; carnivores = 0% vegetation, total PP = PP - PS): and omnivores =(1.00-PS-PV)/2 for representative species.

b. PV = percentage of diet represented by vegetation ingested (unitless).

c. PS = percentage of diet represented by soil ingested (unitless). Soil ingestion from Beyer et al. (1994) and Arthur and Gates (1988) - (pronghorn, jackrabbit).

d. ED = exposure duration (fraction of year spent in the affected area) (unitless). Conventions: Residents - 0.05-1.00 (birds and migratory and transient mammals) 1.00 (small mammals); breeding – 0.05-0.65 (birds and migratory and transient mammals); summer visitors - 0.05-0.25; winter visitors - 0.05-0.25.

e. IR = ingestion rate [derived using allometric equations based on body weight (Nagy, 1987)] (kg/day).

f. BW = receptor-specific body weight (kg). Mammalian body weight primarily from Burt and Grossenheider (1976), the general literature and EPA Exposure Factors Handbook (1993a) for some species. Avian body weights from Dunning (1993).

g. Home ranges from Hoover and Wills (1987) and the general literature. Unknown = defaulted to an SUF of 1.0 (i.e., assumes 100% site use).

h. WI = water ingestion rates derived using allometric equation (EPA, 1993a).

i. Compiled from Diller and Johnson (1988).

the area affected, and it is likely that these species consume prey, vegetation, and soil from unaffected areas.

ED is based on the migratory pattern of the receptors. This is determined using the status and abundance data compiled for site species (VanHorn et al. 1995). Five status/abundance categories are represented: resident, breeding, summer visitor, migratory, and winter visitor. For year-round residents, ED is assumed to be 1 (i.e., receptors potentially spend up to 100% of the year on the assessment area). For species breeding onsite, the ED is assumed to be 0.65, (i.e., receptors potentially spend up to 65% of the year on the assessment area). For migratory summer and winter visitors, the ED is assumed to be 0.25 (i.e., receptors potentially spend up to 25% of the year on the assessment area). The most conservative ED is chosen from the functional group members to represent the functional group ED.

Food intake rates (g dry weight/day) for passerine birds, nonpasserine birds, rodents, herbivores, all other mammals, and insectivorous reptiles can be estimated using the following allometric equations (Nagy 1987). The equation for insectivorous reptiles can be conservatively assumed to be applicable to the carnivorous reptiles (R322). Because of the fact that different allometric equations may apply to different species within a group, the equations representative of all mammals and avians were used to calculate the ingestion rate for the functional groups.

$$\text{Food intake rate} = 0.398\, BW^{0.850} \text{ (passerines)} \quad (7\text{-}1)$$

$$\text{Food intake rate} = 1.110\, BW^{0.445} \text{ (desert birds)} \quad (7\text{-}2)$$

$$\text{Food intake rate} = 0.648\, BW^{0.651} \text{ (all birds)} \quad (7\text{-}3)$$

$$\text{Food intake rate} = 0.583\, BW^{0.585} \text{ (rodents)} \quad (7\text{-}4)$$

$$\text{Food intake rate} = 0.577\, BW^{0.727} \text{ (mammalian herbivores)} \quad (7\text{-}5)$$

$$\text{Food intake rate} = 0.235\, BW^{0.822} \text{ (all other mammals)} \quad (7\text{-}6)$$

$$\text{Food intake rate} = 0.015\, BW^{0.874} \text{ (desert mammals)} \quad (7\text{-}7)$$

$$\text{Food intake rate} = 0.013\, BW^{0.773} \text{ (reptile insectivores)} \quad (7\text{-}8)$$

where

BW = body weight in grams.

An equation for ingestion rates for carnivorous reptiles (R322) was compiled from Diller and Johnson (1988).

$$\text{Food intake rate} = 0.00001\text{BW}^{1.5} \text{ (carnivorous reptiles)} \quad (7\text{-}9)$$

Exposure for each functional group was calculated using best available estimates for species-specific exposure parameters. Each of the receptors was evaluated individually. Potential exposures for these species was determined based on the species' life history and feeding habits. Quantification of exposures used species-specific numerical exposure factors including body weight, ingestion rate, fraction of diet composed of vegetation or prey, and soil consumed from the affected area. Species parameters used to model intakes by the functional groups are presented in Table 7-14. These values are derived from the various key species in the functional groups. The parameters in Table 7-14 are the maximum percent prey, percent vegetation, percent soil, and ED and the maximum ingestion-rate-to-body-weight ratio and home range for each functional group because these values were the most conservative. Percent soil ingestion rate values come from the *Wildlife Exposure Factors Handbook* (EPA 1993a), Beyer et al., (1994) and site-specific data, where available.

7.3.2.1 Exposure to Nonradiological Contaminants. The exposure equation used to calculate average daily soil intake is used to calculate the dose to functional groups and T/E species. For example, dose (intake) in mg/kg body weight-day can be estimated using the following equation, as adapted from EPA's *Wildlife Exposure Factors Handbook* (EPA 1993a):

$$EE_{tot} = \frac{[(PP \times CP) + (PV \times CV) + (PS \times CS)] \times IR \times ED \times SUF}{BW} \qquad (7\text{-}10)$$

where

EE_{tot} = estimated exposure from all complete exposure pathways (mg/kg body weight-day)

PP = percentage of diet represented by prey ingested (unitless)

CP = concentration of contaminant in prey item ingested (mg/kg)

PV = percentage of diet represented by vegetation ingested (unitless)

CV = concentration of contaminant in vegetation ingested (mg/kg)

PS = percentage of diet represented by soil ingested (unitless)

CS = concentration of contaminant in soil ingested (mg/kg)

IR = ingestion rate (kg/day), food intake rate (g/day) divided by 1,000 g/kg

ED = exposure duration (fraction of year spent in the affected area) (unitless)

BW = receptor-specific body weight (kg)

SUF = site usage factor (site area divided by home range; cannot exceed 1) (unitless).

The concentration of contaminant in prey can be estimated using the equation (VanHorn et al 1995):

$$CP = CS \times BAF \qquad (7\text{-}11)$$

where

CP = concentration in prey ingested (mg/kg)

CS = concentration of contaminant in soil (mg/kg)

BAF = contaminant-specific bioaccumulation factor (unitless).

The concentration of contaminant in vegetation can be estimated using the equation (VanHorn et al. 1995):

$$CV = CS \times PUF \tag{7-12}$$

where

CV = concentration of contaminant in vegetation (mg/kg)

CS = concentration of contaminant in soil (mg/kg)

PUF = contaminant-specific plant uptake factor (unitless).

Finally, burrowing and nonburrowing animals are potentially exposed to different soil concentrations. In order to account for this, nonburrowing animals are expected to only ingest surface soils; however, their prey is still considered to be potentially exposed to subsurface conditions.

Combining Equations 7-10 through 7-12 gives the following total dose to nonradiological contaminants in mg/kg body weight-day:

for nonburrowers

$$EE_{tot} = [(PP \; x \; BAF + PV \; x \; PUF + PS) \; x \; CS_g \; x \; IR + WI \; x \; CW]\left(\frac{ED \; x \; SUF}{BW}\right) \tag{7-13}$$

and for burrowers

$$EE_{tot} = [(PP \; x \; BAF + PV \; x \; PUF) \; x \; CS_g \; + CS_s \; x \; PS] \; x \; IR + WI \; x \; CW \; x\left(\frac{ED \; x \; SUF}{BW}\right) \tag{7-14}$$

where

WI = water ingestion rate (L/d)

CS_s = surface soil concentration (mg/kg)

CS_g = the greater of the surface and subsurface soil concentrations (mg/kg)

CW = concentration of contaminant in water (mg/L).

The water ingestion is calculated using the following equations (EPA 1993a):

$$WI = 0.059 \; BW^{0.67} \text{ (for birds)} \tag{7-15}$$

$$WI = 0.099 \; BW^{0.90} \text{ (for mammals)} \tag{7-16}$$

Due to the complexity of water ingestion by reptiles, no general reptilian water ingestion equation is available. It is assumed here that desert reptiles, such as those found at the INEEL, get their water solely from prey.

The following functional groups and T/E species are considered burrowers: AV210A, M122A, M222, M322, M422, M422A, R222, R322, burrowing owl, pygmy rabbit, and the sagebrush lizard.

A summary of the contaminant-specific PUFs and BAFs for nonradionuclides contaminants are presented in Table 7-16. A more detailed discussion is included in Appendix J. PUFs for all metals are taken from Baes et al. (1984). The PUF and BAFs for organics are estimated using the Travis and Arms (1988) equation of 1.588-0.578 log K_{ow} and -7.735 + 1.033 log K_{ow}, respectively. Log partitioning coefficients (K_{ow}s) were taken from Montgomery and Welkom (1990).

7.3.2.2 Uncertainty Associated with Functional Groups. The selection of receptor parameters used is designed to ensure that each of the members of the functional groups is conservatively represented. Since all members of a functional group are considered similar, it is reasonable to assume that all members of a group will be equally exposed to site-related contaminants. Quantification of dose for each functional group is expected to provide sufficient data to assess the general condition of the ecosystem and to be adequately protective of the majority of species potentially inhabiting WAG 4. In addition, sensitive species are included on the list of receptors for which dose is calculated. Hence, uncertainty associated with the selection of receptor parameters is expected to minimally influence dose estimates.

7.3.2.3 Uncertainty Associated with the Ingestion Rate. Estimation for terrestrial receptors intake (ingestion) estimates used for the terrestrial receptors is based upon data in the scientific literature, when available. Food ingestion rates are calculated by use of allometric equations reported in Nagy (1987). Uncertainties associated with the use of allometric equations could result in either an over- or underestimation of the true dose rate, since not all of these values are known exactly.

7.3.2.4 Uncertainty Associated with the Receptor Site Usage. The calculation of dose incorporated the probability that the receptors may use or inhabit each site. The SUF is defined as the affected area (ha) divided by the home range (ha) of the receptor. If a given receptor's home range is larger than the affected area, then it is reasonable to assume that the receptor may not spend 100% of its life within the site area. Incorporation of the SUF adjusts the dose to account for the estimated time the receptor spends on the site. The less time spent on the site, the lower the dose. However, most home ranges are estimated from available literature values and allometric equations. Home range and usage of areas also vary from season to season as well as year to year (depending on the species of interest), and are difficult to measure. This uncertainty could result in either an over- or underestimation of the true dose rates.

7.3.2.5 Uncertainty Associated with the PUFs and BAFs. Using PUFs to estimate plant concentrations has the advantages that it is easy to use and requires minimum data inputs (i.e., the measured or estimated concentration of metal in soil and a PUF taken from the literature). A PUF of 0.01 indicates that the plant concentration should be 1/100th of the total concentration in soil. For this WAG ERA, PUFs for metals are taken from Baes et al. (1984). Although preference is given to studies that reported the steady-state concentration of metals in plants at edible maturity, various soil properties are not considered and data for numerous plant species (both animal feeds and those consumed by humans) are combined. However, since root uptake of metals is a complex process that depends on various soil properties (e.g., pH, CEC, and organic matter content) as well as the metal and type of plant involved, the use of generic or crop-specific PUFs taken from the literature may not accurately estimate the concentration of metals in plants for all environmental conditions and species that may occur on WAG 4.

Table 7-16. PUFs and BAFs for WAG 4 nonradionuclide contaminants (unitless).

	PUF[a,b]	BAF[a,c] for Insectivores	BAF[a,c] for Predators	BAF[a] for Omnivores
Inorganic Contaminants				
Antimony	2.0E-02	9.0E-01	6.0E-03	9.0E-01
Arsenic	4.0E-02	1.0E+00	4.0E-02	1.0E+00
Barium	1.5E-02	1.0E+00	1.5E-02	1.0E+00
Cadmium	5.5E-01	1.1E+00	1.9E+00	1.9E+00
Chromium III	7.5E-03	6.0E-02	2.0E-01	2.0E-01
Cobalt	1.1E+00	1.1E+00	2.0E-02	1.0E+00
Copper	4.0E-01	1.0E+00	2.0E-01	1.0E+00
Lead	4.5E-02	3.0E-01	6.0E-01	6.0E-01
Manganese	9.8E+00	1.0E+00	2.5E-01	1.0E+00
Mercury	9.0E-01	4.0E-01	7.0E-01	7.0E-01
Nickel	6.0E-02	1.0E+00	6.0E-03	1.0E+00
Nitrate	1.0E+00	1.0E+00	1.0E+00	1.0E+00
Selenium	2.5E-02	1.0E+00	2.5E-02	1.0E+00
Silver	4.0E-01	1.0E+00	4.0E-01	1.0E+00
Vanadium	5.5E-03	1.0E+00	1.0E+00	2.5E-03
Zinc	1.5E+00	1.0E+00	7.0E-01	1.0E+00
Organic Compounds[d]				
Acetone	5.3E+01	5.5E-07	5.5E-07	5.5E-07
Aroclor-1254	1.3E-02	4.0E-04	4.0E-04	4.0E-04
Benzo(a)anthracene	2.3E-02	1.0E-02	1.0E-02	1.0E-02
Benzo(a)pyrene	1.2E-02	4.1E-04	4.1E-04	4.1E-04
Benzo(b)fluoranthene	1.2E-02	4.1E-04	4.1E-04	4.1E-04
Benzo(g,h,i)perylene	6.7E-03	6.5E-04	6.5E-04	6.5E-04
Benzo(k)fluoranthene	1.2E-02	4.1E-04	4.1E-04	4.1E-04
Chrysene	2.2E-02	2.5E-04	2.5E-04	2.5E-04
Dibenz(a,h)anthracene	1.2E-02	4.1E-04	4.1E-04	4.1E-01
Indeno(1,2,3-cd)pyrene	6.8E-03	6.5E-04	6.5E-04	6.5E-04
Pyrene	5.8E-02	1.9E-03	1.9E-03	1.9E-03
TPH	1.0E+00	1.0E+00	1.0E+00	1.0E+00
Xylene	5.0E-01	2.2E-05	2.2E-05	2.2E-05

a. Development and/or calculation of PUFs and BAFs are documented in Appendix J.

b. PUF = Plant uptake factor.

c. BAF = Bioaccumulation factor.

d. The following organic compounds were not assessed: 2-methylnaphthalene, 4-methyl-2-pentanone, benzo(a)anthracene, pyrene, chloromethane, dibenzofuran and pentachlorophenol.

The PUF for organics is estimated using the geometric mean regression equation developed by Travis and Arms (1988) and using log K_{ow} values. The reliability of estimated PUFs is directly related to the reliability of the K_{ow} values used for the organic compounds. Since K_{ow} values can vary greatly, use of the Travis and Arms (1988) equation to estimate a PUF for organic compounds may over- or underestimate the true dose for organic compounds.

There is a great deal of uncertainty associated with the bioaccumulation factors (BAFs) used to calculate dose. Very few BAFs are available in the scientific literature, since they must be both contaminant- and receptor-specific. In the absence of specific BAFs, a value of 1 was assumed. This assumption could over- or underestimate the true dose from the contaminant, and the magnitude of error cannot be quantified. Travis and Arms (1988) and Baes et al. (1984) report BAFs for contaminants to beef and milk; all of these are less than 1 for the contaminants at WAG 4. If the terrestrial receptors of concern accumulate metals and PCBs in a similar way and to a comparable degree as beef and dairy cattle, the use of a BAF of 1 for all contaminants and receptors would overestimate the dose. On the other hand, if the terrestrial receptors of concern for WAG 4 accumulate metals and PCBs to a much larger degree than beef and dairy cattle, the assumption of BAFs equal to 1 could underestimate the true dose from the COPCs.

7.3.2.6 Uncertainty Associated with Soil Ingestion. The exposure assessment incorporates percentage of soil ingested by each representative of the functional groups. Although food ingestion rates have the greatest effect on intake estimates, soil ingestion rates could also influence intake rates and, therefore, dose estimates. The EPA Wildlife Exposure Factors Handbook (EPA 1993a), Beyer et al. (1994) and Arthur and Gates (1988) were used to assign soil ingestion parameters for functional groups and individual species. Estimating the percent soil ingested may over- or underestimate the dose since the effect of the estimated values on the overall dose outcome is dependent on the concentration of contaminant in the media of concern.

7.3.3 Ecological Effects Assessment

Ecological effects assessment consists of three elements:

- Selecting quantified critical exposures (QCEs)
- Developing AFs
- Developing TRVs.

Sections 7.3.3.1 through 7.3.3.4 below contain a general description of the procedures of ecological effects assessment and discussions of each of the three elements.

7.3.3.1 General Procedures. A TRV is defined as a dose for a receptor (including sensitive subgroups such as taxa under regulatory protection) that is likely to be without appreciable risk of deleterious effects from chronic exposure. Application of toxicity data derived from surrogate species introduces uncertainty into the risk assessment. The magnitude of this uncertainty depends largely upon (1) the degree of taxonomic difference between the key and test species, (2) the conditions under which the toxicity data are obtained, and (3) the endpoint of interest [e.g., chronic lowest-observed-adverse-effect-level (LOAEL) or no-observed-adverse-effect-level (NOAEL)] and the endpoint measured (e.g., death). Uncertainties associated with extrapolation of toxicity information from literature to site conditions can therefore be offset by applying AFs to the endpoint values identified in the literature.

The approach for TRV derivation used in this WAG ERA was developed by Ludwig et al. (1993) for use at the Rocky Mountain Arsenal Superfund site in Commerce City, CO, and is generally based on the EPA reference dose approach as modified by Lewis et al. (1990). It is predicated on the development and application of AFs, which are intended to explicitly account for variations and uncertainties in the data and necessary extrapolations from it. The types of variation and extrapolation uncertainties explicitly quantified are:

- Variation in sensitivity among the members of a receptor population
- Uncertainty in extrapolating data from one taxon to another
- Uncertainty in using various effect levels to estimate no-effect levels in receptors
- The inability of any single study to adequately address all possible adverse outcomes in a wild receptor population.

The approach of Ludwig et al. (1993) offers several distinct advantages. By carefully identifying the specific types of adjustments needed in the extrapolation, this method permits maximum resolution of what each adjustment is intended to achieve. It emphasizes consensual, data-quality-based development of values for specific AFs rather than defaulting to arbitrary factors. It clearly discriminates between "best estimates" of the values of individual factors and adjustment for overall uncertainty, including the uncertainty associated with the AFs themselves.

The TRVs used for antimony, arsenic, barium, cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel, selenium, silver, thallium, toluene and zinc for plants were taken directly from Suter et al. (1993) and no AF values were assigned. The values presented in that paper are toxicological benchmarks for screening potential COCs for effects on terrestrial plants in soil. These values are for those contaminants potentially associated with DOE sites and were, therefore, appropriately used in the calculations for the INEEL.

7.3.3.2 Selecting Quantified Critical Exposures. TRV development is initiated by reviewing the available toxicological literature and relevant databases for each contaminant and functional group members to identify quantified critical exposures (QCEs) from the best available study. Studies considering nonlethal endpoints and reporting NOAELs are selected, if available. Those reflecting reproductive competence are most preferred as such endpoints are considered to best reflect the population-level impacts of greatest concern in ERA. The following criteria are used to select QCEs:

- Experimental taxa should be as similar as possible to receptors at INEEL site(s), both physiologically and ecologically. With respect to body size, feeding, and behavioral habits, anatomy, and physiology, the surrogate species should be matched as closely as possible to the receptors.
- Test exposure route and medium should be similar to that expected for receptors in the field. For most of the receptors at INEEL, exposure media are limited to soil and dietary items (both animal and vegetable). Liquid intake is largely in the form of metabolic water. Dietary laboratory studies are therefore the most appropriate models for extrapolation. Gavage and drinking water studies will be considered, if necessary, but reduce confidence in the applicability of the study.

- Long-term (preferably lifetime) exposures should be used, as they are closest to exposure patterns occurring in the field.

- Experimental endpoints should represent ecologically significant effects at the population level. In general, loss of a few individuals of a species is unlikely to significantly diminish the viability of the population or disrupt the community or ecosystem of which it is a part. As a result, the fundamental unit for ERA is generally the population rather than the individual, with the exception of T/E and sensitive species (EPA 1992). In general, the most appropriate endpoints for ERA are reproduction, neurological function, and growth and development. For species under regulatory protection, TRVs are based on the most sensitive nonlethal endpoints referring specifically to individuals.

- Doses within the NOAEL-LOAEL bracket should be identified. If these data are not available, the following dose levels (in decreasing order of preference) may be used: chronic-nonlethal-adverse-effect-level > no-effect-level > frank-effect-level (including lethality). The definition of adversity requires considerable analysis of the potential ecological significance of the effects reported. For example, elevated liver weight or enzyme induction could represent an adaptive response rather than a toxic injury.

- Studies should be of high quality, defined as complete in design, with adequate numbers of subjects and dose levels, lifetime duration, explicit analysis of experimental uncertainty, clear results, and well-justified conclusions.

If a single study cannot be selected (e.g., where only acute exposure, lethal endpoint studies are available), then an average of several studies of similar quality using the same or closely similar species may be used. In averaging, extreme outliers, which are defined as greater than two standard deviations from the mean, are excluded. Where similar endpoints are observed in more than one study of similar quality, the lowest QCE should be used.

Information on the toxicological effects on mammalian receptors of the following contaminants is not available. Therefore, these contaminants were not evaluated for potential risk for mammalian receptors.

- 4-methyl-2-pentanone
- chloromethane
- dibenzofuran
- pentachlorophenol

Information on the toxicological effects to avian receptors of the following contaminants was not located. Therefore, these contaminants could not be evaluated for potential risk to avian receptors.

- 4-methyl-2-pentanone
- acetone
- antimony
- barium
- benzo(a)anthracene
- benzo(a)pyrene
- benzo(b)fluoranthene
- benzo(g,h,i)perylene
- benzo(k)fluoranthene
- chloromethane
- chrysene
- dibenz(a,h)anthracene

- dibenzofuran
- indeno(1,2,3-cd) pyrene
- pentachlorophenol
- pyrene
- xylene

7.3.3.3 Developing AFs. Six AFs for extrapolation from experimental studies to field exposures at the INEEL are defined for

I = intrataxon variability

R = intertaxon variability

Q_1 = risk assessor's certainty that the COPC actually causes the critical effect in the receptor, and that it is an ecologically significant effect

Q_2 = extrapolation from short- to long-term EDs

Q_3 = extrapolation across endpoint types to estimate an NOAEL

U = any residual uncertainty in the data evaluation process and estimation of other AFs based on data quality, study design, and known but otherwise unaccounted for extrapolation issues

M = professional judgement to determine another uncertainty factor (M) that is < 10. The magnitude of the M depends upon the professional assessment of scientific uncertainties of the study and database not explicitly treated above; e.g., the completeness of the overall database of the number of animals tested. The default value of M is 1.

Values for these AFs are set based on the quality of the selected study in particular, and of the database in general. Other potentially influential factors include the ecological circumstances of the receptor, regulatory criteria and standards, background contaminants levels, and protection status. To prevent needless overestimation of risk, the maximal AF product (all AFs multiplied together) is scaled to the overall extrapolation error observed in experimental studies designed specifically to determine the uncertainty in such extrapolations. Barnthouse et al. (1990) quantified the range of maximal uncertainty necessary to permit extrapolation of various kinds of toxicity data for various taxa of finfish at the population level. The types of toxicity data used included studies involving particular species of interest and other species, for acute, partial life-cycle, and full life-cycle exposures. The range of maximal uncertainty varied with the type of data used, and ranged from approximately 200 to 400 (Barnthouse et al. 1990). It is assumed that the degree of variability observed among fish taxa is similar to that occurring among other vertebrate taxa.

Based on a systematic review of all available information (Ludwig et al. 1993), a simple, relative scale is developed consisting of "low," "medium," and "high" rankings for each AF, with adjustments made of the basis of specific inherent uncertainty or variability in the particular extrapolations. The quantitative valuation of this scale is designed to be constrained by an upper bound in the range of 200 to 400, and use the most plausible values for each AF.

Specific values for these AFs and a brief description of criteria for their use are presented in Table 7-17. Values for all AFs except Q_1 and M are set at 1 ("low"), 2 ("medium"), and 3 ("high"), with

Table 7-17. AF values and criteria used to develop TRVs for the INEEL.

Adjustment factor	Qualitative ranking	Value	Criteria
I	Low	1	Variability is low
	Medium	2	Variability is moderate or average
	High	3	Variability is high, or information on variability is inadequate
R	Low	1	Test organism and functional group, T/E, C2 are in same taxonomic order and trophic category
	Medium	2	Test organism and functional group, T/E, C2 are in same trophic category but different taxa
	High	3	Test organism and functional group, T/E, C2 are in different trophic categories
Q_1	Low	0.1	Experimental endpoint is highly unlikely to occur in the field
	Medium	0.5	Experimental endpoint is moderately unlikely to occur in the field
	High	1	Experimental endpoint is likely to occur in the field
Q_2	Low	1	Study was of chronic duration
	Medium	2	Study was of subchronic duration
	High	3	Study was of acute duration
Q_3	Low	1	NOAEL
	Medium	2	LOAEL
	High	3	Adverse effect level or frank effect level
U	Low	1	High quality studies
	Medium	2	Studies of reasonable quality
	High	3	Studies with flawed design or incomplete information
M	—	<10	Use professional judgement to determine another uncertainty factor (M).

lower values generally representing greater confidence that the QCEs correspond well with "safe" doses for receptors. The factor Q_1, which expresses the degree of certainty that the experimental effect will not occur in the field or is not of ecological significance, runs on a positive scale equivalent where 0.1 represents high certainty that the effect either does not occur in the receptor or is ecologically irrelevant; 0.5 represents moderate certainty that the effect does not occur or is irrelevant; and, 1 represents reasonable certainty that the effect will occur in the receptor species and is ecologically significant. The factor M is used to adjust uncertainty based on professional judgement. For example, M can be set at 1 if the medium of exposure in the QCE study is similar to field exposure media at this site (i.e., primarily food and soil ingestion). However, because a number of toxicological studies for metals used soluble salts in drinking water as a means of exposure and both the contaminant species and exposure matrix tend to maximize metal absorption (Steele et al. 1990; Griffin and Turuk 1991; Witmer et al. 1991), M may be set at 0.5 to conservatively represent the significantly lower bioavailability of the metal species associated with soils and dietary items in the natural environment. Without M being greater than 1.0, the maximum product of the seven AFs is 243. This AF maximum represents the extent to which valid extrapolation of the data can be applied across experimental protocols or among taxa. More detailed information on the definition and valuation of these factors is available in Ludwig et al. (1993).

7.3.3.4 Developing TRVs. The third element in ecological effects assessment is the derivation of TRVs. TRVs were derived for each functional group by selecting the experimental study with the most appropriate QCE for that chemical and assigning numerical values for all AFs to account for uncertainties associated with extrapolation across species and exposure conditions. The algorithm used for deriving a TRV is

$$TRV = \frac{QCE}{AF} \qquad (7\text{-}32)$$

where

QCE = quantified critical exposure

AF = $[I] \times [R] \times [Q_1] \times [Q_2] \times [Q_3] \times [U] \times [M]$.

Information used to derive TRVs for nonradioactive inorganic and organic contaminants is summarized in this section. The development of TRVs for each contaminant/functional group combination is presented in Appendix J for mammalian and avian receptors. Table J-1 summarizes the TRVs for mammalian functional groups. A summary of the TRVs for avian functional groups is contained in Table J-2. Shading in Tables J-1 and J-2 corresponds to the TRVs chosen for each functional group. When the test organism and the receptor were in the same taxonomic order and trophic category (R = 1), the corresponding TRV was chosen, as shown in heavier shading. If the test organism and receptor are in the same trophic level and different taxa, R = 2 was used. Otherwise, the minimum TRV (R = 3) for each COPC was chosen for all mammalian or avian receptors. Little information was found describing the effects of COPCs on reptilian, invertebrate, or terrestrial plant receptors. When available, that information is summarized in Sections 7.3.4 and 7.3.5. Development of TRVs for radionuclides is described in Section 7.3.6.

7.3.4 Development of TRVs for Inorganic Contaminants of Potential Concern

This section contains summaries on the information used in determining the TRVs for the inorganic contaminants for which toxicological studies were located. This information and the adjustment factors used are presented in Appendix I. The inorganic contaminants include:

- antimony
- arsenic
- barium
- cadmium
- chromium
- cobalt
- copper
- lead
- manganese
- mercury
- nickel
- nitrate
- selenium
- silver
- sulfate
- thallium
- vanadium
- zinc

Antimony (CAS No. 7440-36-0). Antimony causes a number of toxic effects in animals, including suppression of weight gain, shortened life span, and damage to liver, heart, thyroid, and kidneys. Trivalent compounds (e.g., antimony trioxide, antimony trisulfide) are about 10 times more toxic than pentavalent forms. The gastrointestinal absorption of trivalent antimony is about 15 - 36% (Weitz and Ober 1965; van Bruwaene et al. 1982; Gerber et al. 1982). The acute toxicity of antimony trioxide is low, with an oral LD_{50} in rats of greater than 20 g/kg (Smyth and Carpenter 1948).

In chronic studies, 5 mg/L potassium antimony tartrate (approximately 0.35 mg/kg-day) in drinking water is associated with slightly decreased life spans in rats (Schroeder et al. 1970) and female mice (Schroeder et al. 1968; Kanisawa and Schroeder 1969). Endpoints examined in these chronic (lifetime) studies included growth and body weight, median life span, longevity, tumor incidence, and histopathology. Other ecologically relevant endpoints (e.g., reproduction) were not examined, and only one dose was administered. Although rats appeared to be more sensitive than mice in these studies, the effects reported are of questionable ecological significance.

No information on the toxicological effects of antimony on avian receptors was located.

Arsenic (CAS No. 7440-38-2). Arsenic is a metalloid element that is widespread in all environmental media, making up about 0.0005% of the earth's crust. Arsenic is commonly present in living organisms and is constantly being oxidized, reduced, or metabolized.

The potential toxicity of arsenic to any organism is dependent on its chemical form. Inorganic arsenicals are generally more toxic than organic arsenicals, and trivalent forms are more toxic than pentavalent forms. Toxicity is related to aqueous solubility, and the order of toxicity (from greatest to least) is arsines > inorganic arsenites > organic trivalent compounds > inorganic arsenates > organic pentavalent compounds > arsonium compounds > elemental arsenic (Eisler 1988a).

Chemical properties contributing to arsenic's toxicity include its ability to bind to protein sulfhydryl groups and to substitute for phosphorus in some biochemical reactions. These chemical properties may also be responsible for arsenic's apparent essentially in several mammalian species (e.g., Frost 1983; Uthus 1992). In fact, arsenical feed additives are used to promote growth in a number of agricultural species (Eisler 1988a). Recent studies have suggested that arsenic has a physiological role in the formation of various metabolites of methionine metabolism (Uthus 1992). The arsenic requirement for growing chicks and rats is approximately 25 mg/kg diet (Uthus 1992). Species differences in the pharmacokinetic disposition of arsenic have significant effects on their sensitivity to its toxic effects. In addition, animals exposed to sublethal levels of arsenic can develop tolerance to subsequent exposures (Eisler 1988a).

A subacute study using domestic sheep was documented (Eisler 1988a) in which a NOEL endpoint using 2.3 mg/kg-day was reported. An LOAEL of 1.5 mg/kg-day was reported in a chronic study using sodium arsenate in rats (Byron et al. 1967). The data did not show a good dose-response curve in the low-dose range.

The National Academy of Sciences reported an LD_{50} of 39 mg/kg-day using sodium arsenite in mallards.

Barium (CAS No. 513-77-9). Little information regarding the toxicity of barium is available. Its acute toxicity is low, with LD_{50}s in experimental animals consistently greater than 100 mg/kg (ATSDR 1992a). High barium concentrations (2 to 10 ppm) in human drinking water have been reported to be associated with elevated cardiovascular mortality, hypertension, and other cardiovascular effects (ATSDR 1992a).

Results in animal studies indicate that acute, intermediate, and chronic oral exposure to barium is not associated with any adverse hematological effects. Developmental effects reported in a study by Tarasenko et al. (1977) in rats reported effects in offspring included increased mortality, increased leukocyte count, disturbances in liver function, and increased urinary excretion of hippuric acid.

Increased blood pressure, depressed cardiac contractility and conduction, and lower cardiac ATP content were observed in rats chronically exposed to 10-100 mg Ba/L in drinking water (Perry et al. 1983 1985, 1989; Kopp et al. 1985). The NOAEL exposure level identified in these studies was 1 mg/L, or approximately 0.5 mg/kg/day.

No information on the toxicological effects of barium on avian receptors was located.

Cadmium (CAS No. 7440-43-9). Cadmium is found naturally in the environment due to chemical weathering of rocks. It is generally found in soil as free cadmium compounds (ATSDR 1993). There is no evidence that cadmium is biologically essential (Eisler 1985a). Cadmium is not reduced or methylated by microorganisms (ATSDR 1993).

Birds and mammals are comparatively resistant to cadmium toxicity as compared to aquatic species. Sublethal effects of cadmium include growth retardation, anemia, and testicular damage (Hammons et al. 1978) as cited in Eisler (1985a). Cadmium readily reacts with sulfhydral groups and may inhibit enzymatic reactions (Eisler 1985a). Bioaccumulation of cadmium has been reported in aquatic systems, however, only lower trophic levels are reported to exhibit biomagnification (Eisler 1985a). Accumulation of cadmium in avian species has been reported in liver and kidneys.

Chickens exposed to cadmium in the diet had reduced growth rates in a study by Pritzl et al. (1974). Behavioral changes were observed in young American black ducks when parents were fed 4 ppm cadmium for 4 months before egg-laying (Heinz and Haseltine 1983, as cited in Eisler 1985a).

Chromium (CAS No. 7440-47-3). Chromium (III) is an essential nutrient (for insulin function) in mammals. However, it is interconvertible in the environment with the more toxic species chromium (VI), depending primarily on the redox potential and pH of the soil (Bartlett 1991). Chromium (VI) is generally more toxic than chromium (III). Although most chromium (VI) is reduced to chromium (III) in the acidic environment of the stomach (Donaldson and Barreras 1966), chromium (VI) compounds are absorbed significantly more efficiently from the gastrointestinal tract (2 to 10% of administered dose) than chromium (III) compounds (Outridge and Scheuhammer 1993). Once absorbed, chromium (VI) is quickly reduced to the trivalent form. The damaging effects of chromium (VI) are due to its greater membrane permeability, which allows it to cross biological membranes and oxidize cellular components not normally accessible to chromium (III). As a result, the differences in systemic toxicity are primarily attributable to differential solubilities and absorption rates of the two valence states (Franchini and Mutti 1988).

Chromium (VI) compounds are absorbed significantly more efficiently from the gastrointestinal tract (2 to 10% of administered dose) than chromium (III) compounds. Once absorbed into the blood, chromium (VI) is rapidly taken up by erythrocytes via the general anion channel, and reduced to the trivalent from by various intracellular agents (e.g., glutathione, vitamins C and E, cytochrome P450, DT-diaphorase). Uptake and subsequent reaction appear to be similar in other cell types. Despite the rapidity of these uptake processes, chromium (VI)ɜs mobility and the limited supply of extracellular reductants causes it to be distributed more widely in the body than chromium (III). The intracellular reduction of chromium (VI) to chromium (III) generates unstable intermediate chromium (V) and chromium (IV) ions, active oxygen species (hydroxyl and superoxide radicals, singlet oxygen), and thiyl and organic radicals that are responsible for the cytotoxicity, mutagenicity, and carcinogenicity of the hexavalent form (reviewed by Manzo et al. 1992; Cohen et al. 1993; OɜFlaherty 1993; Outridge and Scheuhammer 1993).

As noted above, chromium exhibits a pattern of biominification rather than biomagnification in ecological food webs. Because the speciation of chromium (VI) taken up by plants is poorly understood, it is assumed to be the primary form of exposure to herbivores. However, because chromium (VI) is immediately converted to chromium (III) in animal tissues, carnivorous receptors will be primarily exposed to the less toxic trivalent form.

Pregnant female mice receiving 250 mg/L potassium dichromate in drinking water throughout gestation showed no clinical signs of toxicity, but produced significantly fewer viable offspring (Trivedi et al. 1989). In the dog, 6 mg/L in drinking water (approximately 0.3 mg/kg-day) was a chronic NOAEL [Steven et al 1976 (cited in Eisler 1986a)]. A similar level was without observable effects in a study by Anwar et al. (1961).

Rats exposed to high concentrations of chromium oxide in their diets for more than 2 years showed no decreased body weight, food consumption, life span, or histological abnormalities in major organs (Ivankovic and Presussmann 1975).

Cobalt (CAS No. 7440-48-4). Cobalt is a dietary essential for ruminants and horses in which it is incorporated into vitamin B-12. Signs of cobalt deficiency in cattle and sheep are loss of appetite, body weight loss, emanciation, and anemia. Cobalt deficiency is more likely than cobalt toxicosis.

Environmental exposures to high levels in cobalt rarely occur. Characteristic signs of chronic toxicosis for most species are species are reduced feed intake and body weight, emanciation, anemia, hyperchromemia, debility, and increased liver cobalt (Turk and Kratzer, 1960).

A study by Brewer (1940) where cobalt was mixed with the food of dogs in amounts equivalent to 5, 10, 15, and 20 and 30 mgm at no time during the course of the four week study showed any toxic signs.

Adding cobalt in the form of cobalt chloride to the diet at levels up to 200 ppm did not result in toxicosis in pigs fed a diet adequate in iron (Huck and Clawson, 1976).

A study by Hill (1979) observed growth retardation and decreased resistance to infection in chicks fed cobalt in protein mixtures.

Cobalt has a wide variety of uses including its use in superalloys (alloys that maintain their strength at high temperatures approaching their melting points) and as a catalyst. The most abundant of the radioactive isotopes of cobalt, Co-60, is produced in nuclear explosions and in reactors. Its radiological half-life is 5.27 years (Eisenbud 1987).

The transport of atmospheric cobalt depends on its state (e.g. gas, vapor, or particle) and on meteorological conditions such as wind, precipitation, topography, and vegetation. The transport of cobalt from atmosphere to soil and surface water occurs as a result of dry and wet deposition.

As for most metals, sediment and soil are the final repository for cobalt emitted into the environment by humans. Most of the cobalt released into water eventually reaches lakes via the transport river transport of dissolved and suspended particles. Cobalt is not significantly adsorbed by organic materials (e.g., humic and fulvic materials) in water.

The transport of cobalt in soil depends on its adsorption/desorption. Cobalt is retained by oxides such as iron and magnesium oxide, crystalline materials such as aluminosilicate and geothite, and natural organic substances in soil. Cobalt has a tendency to form soluble complexes with dissolved organic matter. In clay soil, the adsorption may be due to ion exchange at the cationic sites on clay with either simple ionic or hydrolized ionic species such as $CoOH^+$. At higher soil pH, the mobility of cobalt decreases, probably due to the formation of hydroxide or carbonate. The distribution coefficient of cobalt in a variety of soils ranges from 0.2 to 3800. Therefore, in most soils, cobalt is more mobile than lead, chromium, zinc, and nickel, but less mobile than cadmium (Baes and Sharp 1983; King 1988; Smith and Carson 1981).

Copper (CAS No. 7440-50-8). Copper is widely distributed in nature and is an essential element for (1) the normal function of several critical enzymes and (2) the utilization of iron. Copper deficiency is, therefore, usually a greater health concern than copper excess. Copper absorption in the gastrointestinal tract is normally regulated by body stores. Absorbed copper is transported to the liver, where it may be incorporated into ceruloplasmin (a copper transport and donor molecule) and excreted into the plasma, stored as metallothionein or in lysosomes, or excreted via the bile (reviewed by Nederbragt et al. 1984).

Depressed food intake, body-weight gain, egg number and weight, and organ weights are associated with copper excess in poultry (Stevenson and Jackson 1981). The pair-feeding study was conducted to determine whether these effects were associated with direct toxicity or the accompanying marked reduction in food intake (Stevenson and Jackson 1981). Body weight, food intake, organ weights, egg production, egg weight, clinical chemistry parameters, and organ Cu, Fe, and Zn concentrations were monitored in laying hens fed varying concentrations of copper in their diet for 6 weeks (Stevenson and Jackson 1981). A NOAEL of 24 mg/kg/day was identified and used to develop TRVs for avian functional groups.

High doses of copper have caused liver and kidney damage as well as anemia in a number of species. It has been observed that the stomach is also a target in rats and mice (Hebert et al. 1993). This well-designed subchronic feeding study examined histopathology, clinical pathology, reproductive toxicity, and tissue metal accumulation in males and females of both species.

An oral NOAEL was established in a chronic study of young calves (Cunningham 1946). The study confirms that young calves are susceptible to copper.

Lead (CAS No. 7439-92-1). Lead is a ubiquitous trace constituent in rocks, soils, plants, water, and air, with an average concentration of 16 mg/kg in the earth's crust (Eisler 1988b). Lead has four stable isotopes: Pb-204 (1.5%), Pb-206 (23.6%), Pb-207 (22.6%), and Pb-208 (52.3%). Lead occurs in four valence states: elemental (Pb^0), monovalent (Pb^+), divalent (Pb^{+2}), and tetravalent (Pb^{+4}). In nature, lead occurs mainly as Pb^{+2} and is oxidized to Pb^{+4}. Metallic lead is relatively insoluble in hard water. Some lead salts are somewhat soluble in water. Of the organoleads, tetraethyllead and tetramethyllead are the most stable and are highly soluble in many organic solvents but are fairly insoluble in water. Both undergo photochemical degradation in the atmosphere to elemental lead and free organic radicals. Organolead compounds are primarily anthropogenically-produced (Eisler 1988b).

Lead is neither essential nor beneficial to living organisms. Lead affects the kidney, blood, bone, and central nervous system. Effects of lead on the nervous system is both functional and structural. Lead toxicity varies widely with the form and dose of administered lead. In general, organolead compounds are more toxic than inorganic lead. In nature, lead occurs mainly as divalent, Pb^{2+}. Ingestion of lead shot by regulatory waterfowl is a significant cause of mortality in these species.

Hatchlings of chickens, quail, and pheasants are relatively tolerant to moderate lead exposure (Eisler 1988b). There was no effect on hatchling growth of these species at dietary levels of 500 mg/kg or on survival to 2,000 mg/kg lead (Hoffman et al. 1985 as cited in Eisler 1988b). Altricial species are generally more sensitive to lead than precocial species (Eisler 1988b) of avian insectivores. American kestrel (*Falco sparverius*) exposed to 50 mg/kg/day metallic lead in diets did not exhibit effects on survival or reproductive success (Colle et al. 1980).

Manganese (CAS No. 7439-96-5). The bioavailability of different forms of manganese varies considerably depending on different exposure conditions. There is potentially higher bioavailability of manganese from drinking water than food. It is also important to recognize that various dietary factors as well as the form of manganese can have a significant bearing on the dose absorbed from the gastrointestinal tract. For instance, many constituents of a vegetarian diet (e.g., tannins, oxalates, phytates, fiber, calcium, and phosphorus) have been found to inhibit manganese absorption presumably by forming insoluble complexes in the gut. Thus, herbivores are more likely to be resistant to manganese toxicity. Also, the form of manganese can significantly influence toxicity. For example, mice receiving the two soluble forms of manganese (chloride and acetate salts) were found to gain significantly less weight than controls, while mice consuming the insoluble forms of manganese (carbonate and dioxide salts) appeared to actually gain slightly more weight than controls.

DiPaolo (1964) subcutaneously or intraperitoneally injected DBA/1 mice with 0.1 mL of an aqueous of solution 1% manganese chloride twice weekly for 6 months. A larger percentage of the mice exposed subcutaneously (24/36; 67%) and intraperitoneally (16/39; 41%) to manganese developed lymphosarcomas compared with controls injected with water (16/66; 24%). In addition, tumors appeared earlier in the exposed groups than in the control groups. The incidence of tumors other than lymphosarcomas (i.e., mammary adenocarcinomas, leukemias, injection site tumors) did not differ significantly between the exposed groups and controls.

A study reporting the minimum manganese requirements in chickens was used to derive a TRV of 2.9 mg/kg/day. Guinea fowl were found to have reduced hatchability and increased deformed embryos when fed diets deficient in manganese (Offiong and Abed 1980).

For rats, the estimated requirement is 50 mg Mn/kg diet (Rogers 1979). A dietary reproduction study in rats exposed to 250 ppm manganese (13 mg/kg/day) was used to develop a TRV of 1.1 mg/kg/day (Laskey et al. 1982).

Mercury (CAS No. 7439-96-5). Mercury exists in the environment in three oxidation states: the elemental state (Hg^0), mercurous (Hg^{+1}) state, and mercuric (Hg^{+2}) state. Although the generally more toxic organic forms of mercury are unlikely to persist in the environment, they (in particular, methylmercury) may be formed in biotic tissues and are known to biomagnify through ecosystems, particularly aquatic systems (reviewed by Wren 1986; Scheuhammer 1987).

Because of its chemical stability and lipophilicity, methylmercury readily penetrates the blood-brain barrier. The central nervous system is thus a major target organ in both mammals and birds. However, reproductive effects have been reported at even lower doses. Methylmercury can be converted to inorganic mercury both in tissues and by microflora in the gut. The homolytic cleavage of the mercury-carbon bond leads to generation of reactive intermediates, e.g., methyl and metal radicals, which cause cellular damage (reviewed by Wren 1986; Scheuhammer 1987; Manzo et al. 1992).

The effects of mercury on avian herbivores, insectivores, and carnivores were evaluated as follows. For herbivores, the effects of organic mercury compounds on galliformes (e.g. domestic chickens, quail, and pheasants) have been investigated by several groups. However, no study was reviewed that identified a NOAEL. The lowest LOAEL for relevant endpoints (reproductive success) of several similar studies was found in a study of the effects of mercury on birds (Fimreite 1979). Reduced egg production, shell thickness, and hatchability in pheasants fed seed treated with organomercurial fungicide were observed.

Three goshawks were fed a diet of chickens that had eaten wheat dressed with an organomercurial fungicide (Borg et al. 1970). The tissue of the chickens contained 10 to 40 ppm of mercury, mostly as methylmercury. The hawks died after 30 to 47 days; their total mercury intake was about 20 mg/bird.

Two studies examined the effects of subchronic methylmercury exposure on the reproductive competence of male and female rats (Khera and Tabacova 1973; and Khera 1973). The NOAEL identified for both sexes was 0.25 mg/kg/day. Much less information is available regarding methylmercury toxicity to herbivores. In a study of acute methylmercury toxicity in mule deer (*Odocoileus hemionus hemionus*), 17.88 mg/kg was said to be the LD_{50} (Eisler 1987a). A number of studies have examined the effects of chronic methylmercury ingestion on carnivorous mammals, particularly cats (e.g., Albanus et al. 1972; Charbonneau et al. 1976; Eaton et al. 1980) and mink (e.g., Aulerich et al. 1974; Wobeser et al. 1976; Wren et al. 1987). The chronic toxicity of cats study was considered superior to other available studies because of its long duration (2 years), use of relatively large group sizes, detailed examination of endpoints, identification of both no-effect and effect levels, and administration of mercury via both contaminated fish and addition to diet (Charbonneau et al. 1976).

Nickel (CAS No. 7440-02-0). Small amounts of nickel can be essential for normal growth and reproduction (ATSDR 1988a). Oral exposure to high concentrations of nickel has been reported to adversely affect the hematological system and reproduction.

Rats fed 5 mg/kg/day nickel sulfate in a 2-year dietary study did not produce hepatic changes or altered body weights (Ambrose et al. 1976). This NOAEL was supported by a rat subchronic drinking water study conducted by American Biogenics Corp. (1986) and a rat reproductive study by Research Triangle Institute (RTI 1987). For mammalian herbivores, a subchronic study of cows that did not exhibit reduced food intake or growth rate when fed 250 mg/kg/d nickel carbonate (O'Dell et al. 1979 as cited in NAS 1980). A dietary study exposing dogs to 1,000 ppm nickel did not result in adverse effects (Ambrose et al. 1976).

In a three-generation study by Ambrose et al. (1976), no adverse effects on fertility, gestation, viability and lactation were noted in rats maintained on diets containing nickel sulfate hexahydrate at 0, 250, 500, or 1,000 ppm nickel.

A study by Eastin and O'Shea (1981) fed mallard ducks nickel at concentrations of: 0, 12.5, 50, 200, or 800 ppm. The ingestion had no effect on egg production, hatchability, or survival of ducklings.

Nitrate. *Homo sapiens* have been identified as the most sensitive species. Several studies (Bosch et al. 1950; Walton 1951; Sattelmacher 1962; Simon et al. 1964) indicate that infants' ingestion of formulas made with nitrate-contaminated groundwater at concentrations greater than 10 mg/L caused cyanosis. In infants, the pH of the gastrointestinal system is higher than in adults and this allows for the growth of nitrate-reducing bacteria. These bacteria convert nitrate to nitrite, which then causes methemoglobinemia. Therefore, for humans, the NOAEL is 1.6 mg nitrate as nitrogen/kg-day. Nitrates are a normal component of the human and animal diet.

However, in animal studies, the NOAELs and LOAELs identified are typically much higher. In animal studies, Hugot et al. (1980) identified a LOAEL of 900 mg nitrates as nitrogen/kg-day. This LOAEL is based on a three generation study of rats at doses of 90 to 160 mg nitrate as nitrogen/kg-day administered as sodium nitrate. There were no effects on the reproductive capabilities, but small decreases in birth weight, growth rate during lactation, and changes in organ weights at weaning were observed. A LOAEL of 90 mg nitrates as nitrogen was identified, and assuming that 10% of the nitrate is converted to nitrite, a LOAEL of 900 mg nitrates as nitrogen/kg-day.

Reproductive NOAELs have been observed for hamsters and mice at 66 mg/kg-day (FDA 1972a,b) when administered on days 6-10 and 6-15 of gestation, respectively. Another reproductive NOAEL was determined by Sleight and Atallah (1968) for guinea pigs at 143-204 days. Four dose levels were administered at 12, 102, 507, and 1130 mg nitrates as nitrogen/kg-day. Nitrate at the highest dose level reduced the number of live births, but no adverse effects were observed at the other dose levels.

In drinking water, Druckrey et al. (1963) supplied rats with 20 mg nitrates as nitrogen/kg-day for three generations. No teratogenic effects or adverse effects on reproduction were detected in any generation. Assuming that 10% of the nitrate is converted to nitrite, a NOAEL of 200 mg nitrates as nitrogen/kg-day was established.

Selenium (CAS No. 7782-49-2). Selenium is a critical nutrient and a key component of several enzymes (Eisler 1985b). It is often found in high concentrations in areas where soils have been derived from Cretaceous rocks (Eisler 1985b). Selenium does accumulate to high concentrations in certain species of plants (e.g., *Aster, Astragalus*) (Eisler 1985b). Livestock species ingesting these plants have been reported to exhibit toxic symptoms such as abnormal movements, labored breathing, dilated pupils, bloating, diarrhea, and rapid pulse. No effective treatment is known for counteracting the toxic effects of high levels of ingested selenium. Prolonged exposure to more moderate levels of selenium result in skin lesions involving alopecia, hoof necrosis and loss, emaciation and increased serum transaminases, and alkaline phosphatase in animals (TOXNET 1994). Selenium has been reported to cause growth retardation, decreased fertility, embryotoxicity, fetotoxicity, and teratogenic effects in animals (TOXNET 1994). Birds appear to be particularly susceptible to selenium, particularly in the area of reproductive success. Malformations in chickens and waterfowl have been widely reported (EPA 1993a).

Selenium deficiency is often a greater threat to health than selenium poisoning (Eisler 1985b). Selenium deficiency has been documented in a variety of species including fish, quail, ducks, poultry, rats dogs, domestic grazing animals, antelope, monkeys, and humans (Eisler 1985b). Selenium can also reduce the toxicity of other heavy metals such as thallium, arsenic, and copper (Wilber 1980).

In a study by Rosenfeld and Beath (1954), selenium administered as potassium selenate to sires and pregnant rats through five breeding cycles did not affect reproduction, the number of young reared, or on the reproduction of two successive generations of dams and sires in groups receiving 1.5 ppm selenium. Selenium doses as low as 3.2 mg/kg body weight have resulted in death in sheep (Eisler 1985b).

Silver (CAS No. 7440-22-4). The precious metal silver is relatively rare in the earth's crust and does not occur regularly in animal tissues. As a result, the toxicity of silver has been little studied. Approximately 1-10% of ingested silver is absorbed; as much as 18% may be retained. Silver-protein complexes accumulate in the liver, and biliary excretion (complexed with glutathione) is the major route of elimination. In most tissues, silver is deposited as large granules. With rare exceptions, these deposits are not associated with adverse effects. The LD_{50} of silver in rats is relatively high at 24 mg/kg (reviewed by Rungby 1990).

Silver causes a conditioned deficiency of selenium in rats, decreasing tissue levels of selenium, and the selenoprotein glutathione peroxidase (Ganther 1980). Silver ions complex strongly to sulfhydryl groups and cause preoccupation of hepatocellular membrane lipids (Rungby et al. 1987; Shinogi and Maeizumi 1993). Because of its affinity for sulfhydryls, the degree of binding to cellular macromolecules and toxicity of silver is mitigated by induction of the divalent metal-binding protein metallothionein (Shinogi and Maeizumi 1993). Exposure of fetal and adult rats to silver resulted in deposition in the central nervous system (CSN) (Rungby and Danscher 1983a, b). Pyramidal cells in the developing hippocampus appears to be a sensitive target, exhibiting reduced cellular volume in both pre- and postnatally exposed rats (Rungby et al. 1987; Rungby 1990).

A study by Rungby and Danscher (1984) in which mice exposed to approximately 18 mg/kg day were observed to be "hypoactive." Although silver deposits occurred in certain motor centers of the brain, no association between the concentration of deposits and the extent of hypoactivity was found.

No information on the toxicological effects of silver on avian receptors was located.

Sulfate (CAS No. 14808-79-8). Sulfates are generally of low toxicity. Several studies indicate no adverse effects when sulfate compounds are administered (Brown and Gamatero 1970; Sasse and Baker 1974; Paterson et al. 1979) and others that list the effects of loose feces and decreased intake (Bird 1972; L'Estrange et al. 1969). These five studies were conducted using pigs, chicken, and sheep. One study listed an LD_{50} for a single-dose injection of sodium sulfate monohydrate in mice of 45.6 mg/kg day (Nofre et al. 1963).

No other information was found for the toxicity of sulfate.

Thallium (CAS No. 7440-28-0). Thallium is a nonvolatile heavy metal element that is not used extensively by industry, but is mainly introduced into the environment as a waste product of other metals. Thallium can exist in the atmosphere as an oxide, a hydrazide, a sulfate, or a sulfide. Thallium is present in mono- or trivalent forms in the environment. Thallium(III) forms some organometallic compounds and thallium (I) forms relatively few complexes with the exception of those with halogen, oxygen, and sulfur ligands. Thallium can be removed from solution by adsorption onto clay minerals, bioaccumulation, or (in reducing environments) precipitation of the sulfide. Increased pH values have been found to produce extensive thallium-humic acid interactions while lowering thallium-inorganic interactions. Thallium may be bioconcentrated by living organisms (Callahan et al. 1979). Thallium(I) is more stable and resembles the alkali metal cations in many of its chemical properties. Thallium(III) forms many organic compounds (Zitko 1975), the toxicity of which has been little explored.

Thallium is slightly more acutely toxic to mammals than mercury. The similarity between kinetic profiles of inorganic trivalent and monovalent thallium species suggests that they are converted in vivo to one chemical form, probably monovalent thallium (Sabbioni et al. 1980). Isomorphic with potassium, thallium (I) is readily absorbed and distributed throughout the body, and can substitute for potassium and other monovalent cations in enzymatic reactions. The affinity of thallium (I) for enzymes is 10 times higher than that of potassium, which may cause the observed toxic effects (Zitko 1975). Thallium (I) uncouples oxidative phosphorylation, adversely affects protein synthesis, and inhibits a number of enzymes including alkaline phosphatase and succinic dehydrogenase (Zitko 1975). Thallium is also toxic to plants, inhibiting chlorophyll formation and seed germination.

A study in the 1930s of the acute toxicity of thallium sulfate in game birds including quail (Shaw 1933) formed the basis for the TRV for these functional groups. In a study of the acute toxicity of thallium sulfate in three immature golden eagles (Aquila chrysaetos), the acute oral LD_{50} was estimated to be between 60 and 120 mg/kg (Bean and Hudson 1976). Using the lower end of this range as the QCE, a TRV for raptorial birds at the INEL was derived.

Rats exposed to thallium in their drinking water have shown effects on various neurological (Manzo et al. 1983. Rossi et al. 1988) and reproductive (Formigli et al. 1986) endpoints. Because of the clear ecological relevance of reproductive impairment, a QCE was selected from the study of thallium-induced testicular toxicity (Formigli et al. 1986).

Vanadium (CAS No. 7440-62-2). Vanadium occurs naturally in igneous rock, and shales, in some uranium and iron ores and in association with fossil fuels. In the environment, vanadium is usually combined with oxygen, sodium, sulfur, or chloride (ATSDR 1990). There is no indication that vanadium is nutritionally required by higher plants and annuals (Ammerman et al. 1973). Vanadium uptake into above ground parts of terrestrial plants is low. However, some legumes have been identified as vanadium accumulators (ATSDR 1992). In general, bioconcentration and biomagnification in terrestrial environments appears limited.

Most toxic effects of vanadium are associated with inhalation of vanadium pentoxide (ATSDR 1992). Vanadium is poorly absorbed in the gastrointestinal tract and most is excreted unabsorbed in feces (ATSDR 1992). Ingestion of high levels of vanadium are reported to cause dehydration, emaciation, and diarrhea (Ammerman et al. 1973).

A study of vanadium toxicity in female leghorn chickens by (Kubena and Phillips 1982) was used to develop a TRV of 0.85 mg/kg/kay. A TRV of 0.25 mg/kg/day was derived using a study of the effects of vanadium to mallards (White and Dieter 1978).

A study of the effects of vanadium to mice (Schroeder and Balassa 1967) was used to derive a TRV of 0.5 mg/kg-day for vanadium. There is little information in the literature regarding vanadium toxicity in reminants (Ammerman et al. 1973). A study was used to derive a TRV of 0.42 mg/kg/day (Abbey 1968).

The majority of vanadium is used as an alloying agent (Hillard 1987). Vanadium compounds also have an important role as industrial catalysts. Vanadium-containing catalysts are used in several oxidation reactions such as the manufacture of phthalic anhydride and sulfuric acid. There are also used as corrosion inhibitors in flue-gas scrubbers.

From man-made sources almost all the vanadium released to the atmosphere is in the form of simple or complex vanadium oxides (Byerrum et al. 1974). Vanadium transported within the atmosphere is eventually transferred to soil and water on the earth's surface by wet and dry deposition (Duce and Hoffman 1976).

The transport and partitioning of vanadium in water and soil is influenced by pH, redox potential, and the presence of particulate. It has a natural concentration in groundwater ranging from less than 1 to 10 ppb (Dragun 1988). In water, vanadium generally exists in solution as the vanadyl ion (V^{+4}) under reducing conditions and the vanadate ion (V^{+5}) under oxidizing conditions, or as an integral part of, or adsorbed onto, particulate matter (Wehrli and Stumm 1989). The partitioning of vanadium between water and sediment is strongly influenced by the presence of particulate in the water. Vanadium is transported in water in one of two ways: solution or suspension. It has been estimated that only 13% is transported in solution, while the remaining 87% is in suspension (WHO 1988). Vanadium has a typical native soil concentration range of 20 to 500 parts per billion (ppb).

The mobility of vanadium in soils is affected by the pH of the soil. Relative to other metals, vanadium is fairly mobile in neutral or alkaline soils, but its mobility decreases in acidic soils (Van Zinderen Bakker and Jaworski 1980). Similarly, under oxidizing, unsaturated conditions some mobility is observed, but under reducing, saturated conditions vanadium is immobile (Van Zinderen Bakker and Jaworski 1980).

Zinc (CAS No. 7440-66-6). Zinc is found naturally in the environment and is present in all foods (ATSDR 1988b). It is an essential element and occurs in the environment in the 2+ state. Zinc is likely to be strongly sorbed to soil. Relatively little land disposed zinc is expected to be in a soluble form. Bioconcentration factors of soil zinc by terrestrial plants, invertebrates, and mammals are 0.4, 8, and 6, respectively (ATSDR 1988b).

Excessive dietary zinc has been shown to cause copper deficiency and anemia (ATSDR 1988b). Cadmium has also resulted in the redistribution of zinc to the liver and kidney. Health effects associated with zinc exposure include anemia, liver necrosis, fetal resorption, and in extreme cases, cessation of reproduction (ATSDR 1988b).

A study of sheep by Allen et al. (1983) revealed pathological changes in liver and kidney.

7.3.5 Development of TRVs for Organic Contaminants of Potential Concern

This section contains summaries of the information used to determine the TRVs for the organic contaminants for which toxicological studies were located. The organic contaminants include:

- 2-methylnaphthalene
- acetone
- Aroclor-1254 (PCBs)
- PAHs
- TPH
- xylene

Toxicity information was not found for the following organic contaminants:

- 4-methyl-2-pentanone
- chloromethane
- dibenzofuran
- pentachlorophenol

Toxicity properties for benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, 2-methylnaphthalene, and pyrene are discussed in the polycyclic aromatic hydrocarbons (PAHs) summary. No specific summary for Aroclor-1254 was located so a general summary about PCBs was used.

The development of TRVs for the studies identified for each COPC is contained in Appendix I.

Acetone (CAS NO. 67-64-1). Acetone is a common air contaminant that is moderately toxic by various routes. It is a skin and eye irritant and is narcotic in high concentration (Sax and Lewis 1987).

Acetone was administered via gavage for 90 days to a group of albino rats (30 each sex per treatment group) at treatment levels of 0, 100, 500, or 2500 mg/kg-day (EPA 1986b). Body weights, clinical chemistry, hematology, histopathologic parameters, food consumption, and organ weights were measured. No effects were observed at the 100 mg/kg-day dose. Histopathologic studies showed that rats in the 2500 mg/kg-day group had a marked increase in tubular degeneration of the kidneys and hyaline droplet accumulation with increasing dose.

Inhalation exposure to acetone for a few hours has resulted in rats at concentrations ranging from 16,000 to 50,600 ppm (Bruckner and Peterson 1981) and in guinea pigs from 10,000 to 50,000 ppm (Specht et al. 1939).

No reproductive effects (i.e., no effects on the number of implants/litter, percent live pups/litter, or mean percent resorptions/litter were observed in rats or mice in an inhalation developmental study (NTP 1988). No effects were observed on the fertility of male Wistar rats treated with drinking water containing acetone at 1,071 mg/kg/day for 6 weeks (Larsen et al. 1991).

No information on the toxicological effects of acetone avian receptors was located.

PAHs. In general, unsubstituted PAHs do not tend to accumulate in mammalian adipose tissues despite their high lipid solubility (Eisler 1987b). This is probably because PAHs are rapidly and extensively metabolized. Numerous PAHs are distinct in their ability to produce tumors in most mammal species tested. Acute and chronic exposure to various carcinogenic PAHs has resulted in destruction of the hematopoietic and lymphoid tissues, ototoxicity, respiratory epithelia, and other effects (Eisler 1987b). For the most part, tissue damage occurs at dose levels expected to cause cancer; therefore, the threat of malignancy is the predominant health effect of concern. Target organs affected by PAHs are diverse, probably because of the widespread distribution of PAHs in the body and selective attack by PAHs on proliferating cells. Laboratory studies with mice show that many PAHs affect animals' immune systems. Although ecotoxicological data are scarce, the tendency is for many PAHs to be either carcinogenic (high molecular weight compounds) or acutely toxic (low molecular weight compounds) to many organisms. In addition, chronic toxicities, mainly seen as increased frequencies of hyperplasia and neoplasia in aquatic invertebrates, fish, and amphibians, have been demonstrated in areas with high sediment PAH concentration (Eisler 1987b).

Studies done on mallards revealed no signs of mortality or toxicity during exposure in the adults but produced significant reduction in embryonic growth and a significant increase in the percent of abnormalities, e.g., incomplete skeletal ossification, defects in the eye, brain, liver, feathers, and bill (Hoffman and Gay 1981).

PCBs (CAS 1336-36-3) (Aroclor-1254). PCBs comprise a physicochemically and toxicologically diverse group of 209 compounds whose widespread use and chemical stability have made them ubiquitous in the environment. Because of their generally low acute toxicity, effects on environmental receptors are more likely to be sublethal and chronic than acute. Toxicity and risk assessment of PCB mixtures is complicated by the fact that the 209 congeners differ markedly in both the severity and the nature of their biological effects. The toxic potency of individual congeners is dependent upon their structure. While the approximate isostereomers of 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD)—i.e., coplanar molecules with chlorine atoms in the lateral (but not ortho) ring positions—are the most toxic (and carcinogenic in some species), many others manifest very low acute or chronic toxicity.

The most toxic congeners are also the most potent inducers of mixed-function oxidases as well as some Phase II enzyme activities (reviewed by Safe 1992). These enzymes metabolize not only the inducing PCBs but also a variety of endogenous molecules, such as steroid hormones, that are necessary for normal physiological function. As a result, PCBs may exert adverse effects on development and reproduction in various vertebrate species, including birds (e.g., Koval et al. 1987). In addition, there is considerable difference in the sensitivity of various species to these compounds. Particularly sensitive species include some birds, guinea pigs, and mink (McConnell 1985).

Dahlgren and Linder (1971) and Dahlgren et al. (1972) examined the effects of Aroclor-1254 exposure in pheasants. Although no NOAEL was identified in this work, its focus on a wild species and dosing of both sexes makes it attractive for TRV development. Nine to 10 mg/kg-day Aroclor-1254 reduced sperm concentrations in American kestrels, *Falco sparverius* (Bird et al. 1983).

Linder et al. (1974) identified NOAELs for Aroclor-1254 in a two-generation reproductive study in rats. Many studies have focused on the toxicity of various PCBs to mink, which is a sensitive species (Eisler 1986b; EPA 1993b). Related species such as otter and ferret are considerably less susceptible, suggesting that extrapolation from mink to receptors at the INEEL may not be appropriate.

Total Petroleum Hydrocarbons (TPHs). Petroleum is a combination of several products in varying amounts and combinations. Petroleum is composed of but is not limited to: Gasoline, Diesel, Fuel Oil No.2, Fuel Oil No.4, Kerosene, JP-4, JP-5, and Used Oil. Each of these products is a complex mixture of several hundred hydrocarbon compounds (PAHs, benzene, toluene, ethylbenzene, xylenes, ethylene dibromide, 1,2-dichloroethane, and methyl tert-butyl ether) and other additives (e.g., anti-knock agents, corrosion inhibitors, anti-oxidants, etc.). The actual composition of these products varies depending on the source, age, temperature, and other factors and conditions. Thus, no unique composition exists for any of the aforementioned products. The behavior of these products in the environment depends on the properties of the individual constituents and their concentrations (State of Idaho 1996).

Although no toxicological data are available for TPHs per se, data were obtained for JP-4, a jet fuel petroleum product. No studies on the teratogenicity, embryotoxicity, or reproductive effects are available. Although no LD_{50} was found for JP-4, and oral LD_{50} of 20 g/kg has been reported for kerosene in guinea pigs. Chronic inhalation studies have been conducted with JP-4 in rats, mice, and dogs. No other information was found for the toxicity of TPHs.

The TRVs for benzene was used for TPHs and is thought to have similar toxicity and fate and transport properties.

Xylene (CAS No. 1330-20-7). Acute exposure to xylene via inhalation primarily caused central nervous system (CSN) effects, although acute liver injury was observed in guinea pigs given 1 to 2 g/kg-day intraperitoneally (WHO 1981). An oral LD_{50} value of 4300 mg/kg has been reported for rats (1984, TOXNET). Chronic studies indicate that xylene has a relatively low toxicity over the long-term. No changes were found in rats, guinea pigs, dogs, and monkeys continuously exposed to 80 ppm for 127 days nor in rats exposed to 700 ppm for 130 days (WHO 1981). Ungvary et al. (1980) evaluated the toxicity of xylene in rats. Rats were exposed via inhalation to 35, 300, or 700 ppm continuously on days 7 through 14 of gestation. No adverse effects were observed, and the authors concluded that xylene was not teratogenic. A commercial mixture of xylene was given to mice via gavage at doses of 0, 520, 1030, 2060, 2580, 3100, or 4130 mg/kg-day on days 6 through 15 of gestation (Marks et al. 1982). No adverse effects were observed in either dams or fetuses exposed to levels of 1030 mg/kg-day or less. An exposure of 2060 mg/kg-day and higher approached lethal levels in dams. Fetal weight was significantly decreased and the average percentage of malformations in fetuses significantly increased at these dose levels.

A NOAEL of 250 mg/kg-day was developed based on a well-designed study with animals from two species—F3444N/N Rats and B6CF1 Mice. Adult males and females were tested for 103 weeks and a comprehensive histology was performed.

No data on the toxicological effects of xylene to avian receptors were available.

7.3.6 Identifying Uncertainty Associated with TRVs

The following paragraphs identify the uncertainty associated with the TRVs.

Although QCEs should be derived from the best available literature and all the uncertainties that could be reasonably accounted for are included in the AFs used to calculate TRVs, it is unlikely that any single scheme could suffice to extrapolate available toxicity data for all chemicals among all species. Thus, the remaining uncertainty in these criteria may be even greater than that associated with exposure estimation. Some of the extrapolations required in TRV development are listed in Table 7-18. TRVs are themselves dependent not only on extrapolation procedures but also on sampling adequacy and analytic accuracy, and the completeness and accuracy of response measurements in variable populations of test organisms. Combining results from different species, gathered under different experimental conditions, and extrapolation of results in test organisms to populations of resident species introduce additional, potentially significant sources of error. These errors are:

- While classical human toxicology relies on extrapolation of toxicity data from a handful of mammalian species to one species, an ecotoxicological evaluation must rely on extrapolation from a few test species to a larger number of receptor species spanning variable (and often large) ranges in terms of phylogeny, anatomy, physiology, and life histories. Further, the spatial and temporal heterogeneity of exposure and conditions in natural systems can cause large variations in the doses and responses observed.

- Organisms in the environment are rarely (if ever) exposed to pure compounds alone, but rather to complex mixtures of chemicals whose synergestic effects are unknown.

- Chemicals may be volatilized and transformed to more or less toxic products sequestered in the environment.

Table 7-18. Extrapolations required for developing TRVs.[a]

Extrapolation	Example
Between taxonomic groups	From laboratory mouse to field mouse
Between responses to stressor	From mortality in dogs to a no-observed-effect-level in bobcats
Between laboratory and field conditions	From cage to steppe
Between individual animals to population	From decreased growth rate in captive individuals to effects on a wild population
Between short- and long-term exposure conditions	From acute or subchronic toxicity tests to lifetime exposure
Between laboratory and natural exposure media	Percent uptake of chemical mixed with laboratory diet vs. adsorbed to soil
Between spatial scales	Evaluation of the impact of exposure to a contaminated field on predators whose foraging range is 50 times as large

a. Adapted from EPA (1992).

Our lack of knowledge of environmental variables and limited ability to replicate them in the laboratory or control them in the field results in a high level of uncertainty in our predictions of the effects of stressors on any given ecosystem component from laboratory toxicity tests.

7.4 Risk Characterization

Risk characterization is the final step of the WAG ERA process. The risk evaluation indicates whether there is any indication of risk due to the contaminant concentrations and exposure parameter-calculated dose for INEEL functional groups, T/E, and sensitive species and discusses the uncertainty inherent in the assessment.

For a WAG ERA, the evaluation step has two components starting with a description of the estimation of risk. A summary of the risk evaluation follows the risk estimation. These two components are described in the following sections.

7.4.1 Risk Estimation

This section discusses the estimation of risk. Exposure parameters used to calculate dose to functional groups, T/E, and sensitive species are outlined in Section 7.2. HQs are calculated using the following equation:

$$HQ = \frac{Dose}{TRV}$$

where

HQ = hazard quotient (unitless)

$Dose$ = dose from all media (mg/kg-day or Gy/day)

TRV = TRV (mg/kg-day or Gy/day).

HQs are derived for all contaminants, functional groups, T/E, and sensitive species identified in WAG 4 for each site of concern. The results of the dose calculations are presented in Appendix K. The HQs from the results of the risk analysis are presented in Appendix K. If information was not available to derive a TRV, then an HQ could not be developed for that particular contaminant and functional group or sensitive species combination. These are indicated in the Appendix K tables.

An HQ greater than the target value indicates that exposure to a given contaminant (at the concentrations and for the duration and frequencies of exposure estimated in the exposure assessment) may cause adverse health effects in exposed populations. However, the level of concern associated with exposure may not increase linearly as HQ values exceed the target value. This means that the HQ values cannot be used to represent a probability or a percentage, since an HQ of 10 does not necessarily indicate that adverse effects are 10 times more likely to occur than an HQ of 1. It is only possible to infer that the greater the HQ, the greater the concern about potential adverse effects to ecological receptors.

Exposure point concentrations were calculated in accordance with EPA guidance for calculating concentrations terms (EPA 1992b). The calculated exposure point concentrations correspond to the upper 95 percent confidence limit (95% UCL) of the mean for each of the COPC data sets evaluated. As part of the analysis, all data sets are assumed to have log normal distribution.

EPA (1989a) risk assessment guidance recommends consideration of the positively detected results together with the non-detected results (i.e., sample quantitation limits). Following this guidance, for all results reported as "non-detect," one-half of the sample quantitation limit was assumed as a conservative proxy concentration for each sample with a result below the detection limit.

If the calculated 95% UCL of a chemical in a medium-specific data set exceeds the maximum concentration detected in that data set, EPA (1989a) recommends that the maximum detected concentration be selected as the exposure point concentration. Exceedance of the maximum detected concentration typically occurs when dilution effects have resulted in reporting of very high sample quantitation limits (i.e., non-detect values) or if a limited number of sample results are available (e.g., less than ten).

Soil concentration data calculated in the human health risk assessment were used to assess each site. The use of human health concentration data is assumed to be representative of the range of concentrations to which ecological receptors using a site at WAG 4 are likely to be exposed. If the dose from the contaminant does not exceed its TRV (i.e., are less than 1 for nonradiological contaminants) adverse effects from exposure to that contaminant by ecological receptors are not expected, and no further evaluation of that contaminant is required. Hence, the HQ is an indicator of potential risk.

7.4.2 Uncertainty Association with Hazard Quotients

For the WAG ERA, an HQ is used as an indicator of risk and as a trigger for further evaluation of the site. HQs are ratios of the calculated dose for a receptor from COPCs to the TRV. These ratios provide a quantitative index of risk to defined functional groups or individual receptors under assumed exposure conditions. The ratio or hazard quotient method is commonly used in both human health and ecological risk assessments. It is used in the WAG ERA to eliminate contaminants and sites as a risk to the ecosystem at a WAG level, including sites and contaminants that should be subsequently assessed.

In general, the significance of exceeding a target HQ (see Table 7-13) depends on the perceived "value" (ecological, social, or political) of the receptor, the nature of the endpoint measured, and the degree of uncertainty associated with the process as a whole. Therefore, the decision to take no further action, consider corrective action, or perform additional assessment should be approached on a site-, chemical-, and species-specific basis. Because the unit of concern in ecological risk assessment is usually the population as opposed to the individual (EPA 1992), exceeding conservative screening criteria does not necessarily mean that significant adverse effects are likely.

An HQ less than the target value, which is traditionally 1.0 for non-radionuclide contaminants, implies a Alow likelihood≅ of adverse effects from that contaminant. The HQ target is 1 for nonradionuclides and 0.1 for radionuclides. Nonradiological and radiological contaminants are treated separately, since these two classes of contaminants cause different effects in exposed receptors. Effects from the nonradioactive metals are expected to cause systemic toxicity, while the effects to reproductive processes are typically associated with exposure to ionizing radiation. A separate approach in which the target HQ is set to 1/n, where n is the number of nonradiological or radiological contaminants of concern, could also be used, while the HQ could be set at 0.1 (1/10) for the radiological contaminants. This approach would be too conservative for nonradiological contaminants since it assumes cumulative (simultaneous) exposure to all nonradionuclides and that all contaminants within a given group behave synergistically in a given receptor. Given that all receptors within a functional group may not be simultaneously exposed to all contaminants, and that a synergistic effect may not be seen, this approach may be more stringent than necessary to protect all ecological receptors from nonradiological effects. Therefore, the HQ is set to 1 for all nonradiological contaminants. This method may underestimate the risk in that it does not account for cumulative exposure to multiple contaminants by a given receptor. Or this approach may be more realistic given the amount of conservatism already built into the determination of exposure. The HQ target for radionuclides will be set at 0.1, however. Radionuclides have a greater potential for cumulative dose and the development of TRVs for radionuclides was less conservative than for the nonradiological contaminants.

At this level in the ERA approach at the INEEL, both exposure and toxicity assumptions are generally "worst-case," and represent the upper bound of potential risks to ecological receptors. The HQ approach does not consider variability and uncertainty in either exposure or toxicity estimates, and therefore does not represent a statistical probability of occurrence of adverse ecological effects. Hazard quotients provide essentially a "yes or no" determination of risk and are therefore appropriate for screening-level assessments (EPA 1988b). A limitation of the quotient method is that it does not predict the degree of risk or magnitude of effects associated with specified levels of contamination (EPA 1988b). However, "modified quotient methods" are available that attempt to address this issue. Barnthouse et al. (1986) uses a method in which the conclusions are expressed as "no concern," "possible concern," and "high concern," depending on the ratio of the contaminant concentration to the reference. However, this is not useful in all cases due to specific contaminant characteristics.

A summary of the WAG ERA results is provided in Table 7-19. This table shows the order of magnitude for the largest observed HQ across all functional groups within the site up to an order of 1,000. The actual range of the HQs across functional groups within a site may vary by at least three orders of magnitude. The raw HQ results are shown in Appendix K.

7.4.3 Results of Hazard Quotient Assessment

This section describes the results of the HQ assessment associated with exposure of the functional groups, T/E, and species sensitive to contaminants at WAG 4 sites.

Of the CFA sites assessed in the HQ step of the WAG 4 ERA, twelve sites out of 29 sites were eliminated. Ten sites contained TPH contamination; the other two sites had metals (lead or lead and mercury) contamination. The remaining 18 sites have HQs greater than 1.0 for nonradiological contamination. Based on the WAG ERA assumptions and methodology, arsenic, chromium, copper, lead, and mercury soil contamination were identified as the most common nonradiological contaminants with HQs greater than 1.0 at WAG 4.

CFA-01, Landfill I, has HQs greater than 1.0 from benzo(a)pyrene, chromium III, copper, lead, silver and zinc exposure. The maximum concentration for B(a)P is 0.89 mg/kg. The maximum chromium III concentration is 53 mg/kg. The HQs for B(a)P and chromium III ranges from <1 to 2. The maximum copper concentration is 73.4 mg/kg and the HQ ranged from <1 to 30. The maximum lead concentration is 38 mg/kg and the HQ ranged from ≤ 1 to 100. The maximum silver concentration is 19.5 mg/kg within an HQ between ≤ 1 and 4. The maximum zinc concentration is 230 mg/kg with an HQ between < 1 and 30.

CFA-02, Landfill II, has HQs greater than 1.0 from arsenic, lead, mercury, acetone, benzo(b)fluoranthene, and benzo(k)fluoranthene exposure. The maximum concentration for arsenic is 16 mg/kg. The maximum concentration for lead is 210 mg/kg. The maximum concentration for B(b)F is 0.89 mg/kg with an HQ of < 1 to 1. The maximum concentration for B(k)F is 1.2 mg/kg with an HQ of < 1 to 2. The maximum-observed concentration for mercury, 0.08 mg/kg, only slightly exceeds its background concentration of 0.074 mg/kg, 95%/95% UTL for grab samples (Rood et al 1996). The maximum acetone concentration, 5.8 mg/kg, at 5 ft below grade, is over 10 times higher than the

Table 7-19. Summary of WAG 4 ERA HQ assessment. HQs reported in order of magnitude.

Site Number	Site Description and Size (sq. meters)	Contaminant of Potential Concern	Hazard Quotient	Maximum Concentration Detected (mg/kg)	95% UCL or Maximum Surface Soil Concentration	95% UCL or Maximum Subsurface Soil Concentration	Depth Detected[a]	Data Gaps[b]
CFA-01	Landfill I 4.30E+04	Benzo(a)pyrene	≤1 to 2	0.89	—[c]	0.89	SS	No toxicity reference value (TRV) for plants, reptiles or birds.
		Benzo(b)fluoranthene	<1	0.21	—	0.21	SS	No TRV for plants, reptiles or birds.
		Benzo(g,h,i)perylene	<1	0.16	—	0.16	SS	Used benzo(a)pyrene values.
		Benzo(k)fluoranthene	<1	0.2	—	0.2	SS	Used benzo(b)fluoranthene values for plants, reptiles and birds.
		Chromium III	≤1 to 50	53	—	53	SS	No TRV for reptiles. Screening benchmark concentration (SBC) (1 mg/kg or 0.05 mg/L) used for plants (HQ = 50 for plants only).
		Chrysene	<1	0.45	—	0.45	SS	No TRV for plants, birds or reptiles.
		Copper	<1 to 30	73.4	—	73.4	SS	No TRV for reptiles. SBC (100 mg/kg or 0.05 mg/L) used for plants.
		Dibenz(a,h)anthracene	<1	0.38	—	0.38	SS	Used benzo(a)pyrene values.
		Indeno(1,2,3-cd)pyrene	<1	0.083	—	0.083	SS	Used benzo(a)pyrene values.
		Lead	≤1 to 100	96.5	72	96.5	SS	No TRV for reptiles. SBC (50 mg/kg or 0.02 mg/L) used for plants.
		Mercury	≤1 to 10	0.08	0.08	0.08	S&SS	No TRV for reptiles. SBC (0.3 mg/kg or 0.005 mg/L) used for plants.
		Silver	≤4	19.5	—	19.5	SS	No TRV for reptiles. SBC (2 mg/kg or 0.1 mg/L) used for plants.
		Zinc	≤1 to 30	230	—	230	SS	No TRV for reptiles. SBC (50 mg/kg or 0.4 mg/L) used for plants.
CFA-02	Landfill II 7.07E+05	Arsenic	≤1 to 20	17.0	5.8	17	S & SS	No TRV for reptiles. SBC (10 mg/kg or 0.001 mg/L used for plants.
		Lead	≤1 to 700	210	15	210	S & SS	No TRV for reptiles. SBC (50 mg/kg or 0.02 mg/L) used for plants.

Table 7-19. (continued).

Site Number	Site Description and Size (sq. meters)	Contaminant of Potential Concern	Hazard Quotient	Maximum Concentration Detected (mg/kg)	95% UCL or Maximum Surface Soil Concentration	95% UCL or Maximum Subsurface Soil Concentration	Depth Detected[a]	Data Gaps[b]
		Mercury	≤1 to 8	0.19	0.08	0.08	S & SS	No TRV for reptiles. SBC (0.3 mg/kg or 0.005 mg/L) used for plants.
		2-methylnaphthalene	<1	0.05	—	0.05	SS	Used benzo(a)pyrene values.
		4-methyl-2-pentanone	NA	0.02	—	0.02	SS	No TRVs for any ecological receptor.
		Acetone	≤1 to 20	5.8	0.017	5.8	S & SS	No TRV for plants, reptiles or birds.
		Benzo(a)pyrene	<1	0.59	—	0.59	SS	No TRV for plants, reptiles or birds.
		Benzo(b)fluoranthene	≤1 to 1	0.89	—	0.89	SS	No TRV for plants, reptiles or birds.
		Benzo(g,h,i)perylene	<1	0.52	—	0.52	SS	Used benzo(a)pyrene values.
		Benzo(k)fluoranthene	<1 to 2	1.2	—	1.2	SS	Used benzo(a)pyrene values.
		Chrysene	<1	0.92	—	0.92	SS	No TRV for plants, reptiles or birds.
		Dibenz(a,h)anthracene	<1	0.38	—	0.38	SS	Used benzo(a)pyrene values.
		Dibenzofuran	NA	0.039	—	0.039	SS	No TRV for any ecological receptors.
		Indeno(1,2,3-cd)pyrene	<1	0.65	—	0.65	SS	Used benzo(a)pyrene values.
		Pentachlorophenol	NA	0.074	—	0.074	SS	No TRV for reptiles, birds or mammals. SBC (3 mg/kg or 0.03 mg/L) used for plants.
CFA-04	Pond near CFA-674 6.88E+03	Arsenic	≤1 to 10	12.4	7.63	12.4	S & SS	No TRV for reptiles. SBC (10 mg/kg or 0.001 mg/L) used for plants.
		Barium	≤1 to 3	530	240	530	S & SS	No TRV for reptiles or birds. SBC (500 mg/kg) used for plants.
		Cadmium	≤1 to 1,000	3.4	3.4	2.15[d]	S & SS	No TRV for reptiles. SBC (3 mg/kg or 0.1 mg/L) used for plants.
		Chromium III	<1 to 2	1110	1110	27	S & SS	No TRV for reptiles. SBC (1 mg/kg or 0.05 mg/L) used for plants.
		Cobalt	≤1 to 20	10	10	10	S & SS	No TRV for reptiles. SBC (20 mg/kg or 0.06 mg/L) used for plants.
		Copper	≤1 to 60	140	140	22.0	S & SS	No TRV for reptiles. SBC (100 mg/kg or 0.05 mg/L) used for plants.
		Lead	≤1 to 90	42.4	42.4	21.0	S & SS	No TRV for reptiles. SBC (50 mg/kg or 0.02 mg/L) used for plants.

Table 7-19. (continued).

Site Number	Site Description and Size (sq. meters)	Contaminant of Potential Concern	Hazard Quotient	Maximum Concentration Detected (mg/kg)	95% UCL or Maximum Surface Soil Concentration	95% UCL or Maximum Subsurface Soil Concentration	Depth Detected[a]	Data Gaps[b]
		Mercury	<1 to 30,000	439	439	147	S & SS	No TRV for reptiles. SBC (0.3 mg/kg or 0.005 mg/L) used for plants.
		Nickel	<1 to 50	160	160	34	S & SS	No TRV for reptiles. SBC (30 mg/kg or 0.5 mg/L) used for plants.
		Nitrate	<1	11	11	2.9	S & SS	No TRV for plants or reptiles.
		Silver	≤1 to 20	31	31	ND	S	No TRV for reptiles. SBC (2 mg/kg) used for plants.
		Vanadium	≤2 to 200	46	39	46	S & SS	No TRV for reptiles. SBC (2 mg/kg or 0.2 mg/L) used for plants.
		Aroclor-1254	<1 to 1	2.8	2.8	0.0	S	No TRV for reptiles. SBC (40 mg/kg) used for plants.
CFA-05	Motor Pool Pond 7.43E+03	Arsenic	≤1 to 20	18.4	18.4	8.07	S & SS	No TRV for reptiles. SBC (10 mg/kg or 0.001 mg/L) used for plants.
		Barium	<1 to 3	434	434	317	S & SS	No TRV for reptiles or birds. SBC (500 mg/kg) used for plants.
		Cadmium	<1 to 10,000	38.0	38.0	—	S	No TRV for reptiles. SBC (3 mg/kg or 0.1 mg/L) used for plants.
		Chromium III	≤1 to 90	91.3	91.3	—	S	No TRV for reptiles. SBC (1 mg/kg or 0.05 mg/L) used for plants.
		Cobalt	≤2 to 20	9.4	9.4	9.1	S & SS	No TRV for reptiles. SBC (20 mg/kg or 0.06 mg/L) used for plants.
		Copper	≤1 to 100	342	342	—	S	No TRV for reptiles. SBC (100 mg/kg or 0.05 mg/L) used for plants.
		Lead	≤1 to 1,000	631	631	10.7	S & SS	No TRV for reptiles. SBC (50 mg/kg or 0.02 mg/L) used for plants.
		Manganese	≤1 to 70	767	479	767	S & SS	No TRV for reptiles. SBC (500 mg/kg or 4 mg/L) used for plants.
		Mercury	≤1 to 80	1.2	1.2	—	S	No TRV for reptiles. SBC (0.3 mg/kg or 0.005 mg/L) used for plants.
		Nickel	≤1 to 10	37.1	37.1	36.7	S & SS	No TRV for reptiles. SBC (30 mg/kg or 0.5 mg/L) used for plants.
		4-methyl-2-pentanone	NA	0.065	0.065	—	S	No TRV for any ecological receptor.

Table 7-19. (continued).

Site Number	Site Description and Size (sq. meters)	Contaminant of Potential Concern	Hazard Quotient	Maximum Concentration Detected (mg/kg)	95% UCL or Maximum Surface Soil Concentration	95% UCL or Maximum Subsurface Soil Concentration	Depth Detected[a]	Data Gaps[b]
CFA-06	Lead Shop (outside areas) 2.5E+03	Arsenic	≤1 to 10	14.5	14.5	—	S	No TRV for reptiles. SBC (50 mg/kg or 0.001 mg/L) used for plants.
		Lead	≤1 to 200	153	153	—	S	No TRV for reptiles. SBC (50 mg/kg or 0.02 mg/L) used for plants.
CFA-08	Sewage Plant (CFA-691), Septic Tank (CFA-716), and Drainfield 1.85E+04	Arsenic	≤1 to 10	14.1	11.4	14.1	S & SS	No TRV for reptiles. SBC (10 mg/kg or 0.001 mg/L) used for plants.
		Chromium III	<1 to 2	77.6	77.6	62.0	S & SS	No TRV for reptiles. SBC (1 mg/kg or 0.05 mg/L) used for plants.
		Copper	≤1 to 10	33.0	33.0	27.5	S & SS	No TRV for reptiles. SBC (100 mg/kg or 0.05 mg/L) used for plants.
		Lead	≤1 to 40	18	18	8.8	S & SS	No TRV for reptiles. SBC (50 mg/kg or 0.02 mg/L) used for plants.
		Mercury	≤1 to 30	0.51	0.51	0.34	S & SS	No TRV for reptiles. SBC (0.3 mg/kg or 0.005 mg/L) used for plants.
		Nickel	≤1 to 10	38	38	16	S & SS	No TRV or reptiles. SBC (30 mg/kg or 0.5 mg/L) used for plants.
		Selenium	<1 to 20	1.4	1.4	—	S	No TRV for reptiles. SBC (1 mg/kg or 0.1 mg/L) used for plants.
		Silver	≤1 to ≤10	24.1	24.1	5.1	S & SS	No TRV for reptiles. SBC (2 mg/kg or 0.1 mg/L) used for plants.
		Aroclor-1254	<1	1.3	0.67	1.3	S & SS	No TRV for reptiles. SBC (40 mg/kg) used for plants.
		Benzo(a)pyrene	<1	0.042	0.042	—	S	No TRV for plants, reptiles or birds.
		Chloromethane	NA	0.005	—	0.005	SS	No TRV for any ecological receptors.
CFA-10	Transformer Yard Oil Spills 8.08E+02	Antimony	<1 to 4	9.5	9.5	—	S	No TRV for reptiles or birds. SBC (5 mg/kg) used for plants.
		Arsenic	<1 to 8	11.6	11.6	—	S	No TRV for reptiles. SBC (10 mg/kg or 0.001 mg/L) used for plants.
		Cadmium	≤1 to 2,000	7.3	7.3	—	S	No TRV for reptiles. SBC (3 mg/kg or 0.1 mg/L) used for plants.

Table 7-19. (continued).

Site Number	Site Description and Size (sq. meters)	Contaminant of Potential Concern	Hazard Quotient	Maximum Concentration Detected (mg/kg)	95% UCL or Maximum Surface Soil Concentration	95% UCL or Maximum Subsurface Soil Concentration	Depth Detected[a]	Data Gaps[b]
		Chromium III	<1	102	102	—	S	No TRV for reptiles. SBC (1 mg/kg or 0.05 mg/L) used for plants.
		Cobalt	≤2 to 30	15.7	15.7	—	S	No TRV for reptiles. SBC (20 mg/kg or 0.06 mg/L) used for plants.
		Copper	<1 to 70	259	259	—	S	No TRV for reptiles. SBC (100 mg/kg or 0.05 mg/L) used for plants.
		Lead	<1 to 3,000	3,300	3,300	—	S	No TRV for reptiles. SBC (50 mg/kg or 0.02 mg/L) used for plants.
		Manganese	≤1 to 20	509	509	—	S	No TRV for reptiles. SBC (500 mg/kg or 4 mg/L) used for plants.
		Mercury	<1 to 4	0.09	0.09	—	S	No TRV for reptiles. SBC (0.3 mg/kg or 0.005 mg/L) used for plants.
		Nickel	≤1 to 20	111	111	—	S	No TRV for reptiles. SBC (30 mg/kg or 0.5 mg/L) used for plants.
		Zinc	≤1 to 70	1,150	150	—	S	No TRV for reptiles. SBC (50 mg/kg or 0.4 mg/L) used for plants.
		Aroclor-1254	<1	1.4	1.4	—	S	No TRV for reptiles. SBC (40 mg/kg) used for plants.
CFA-12	Two French Drains (CFA-690) 1.34E+01	Pentachlorophenol	NA	0.25	—	0.25	SS	No TRVs for any ecological receptors.
CFA-13	Dry Well (South of CFA-640) 2.50E+01	Antimony	<1	11.5	—	11.5	SS	No TRV for reptiles or birds. SBC (5 mg/kg) used for plants.
		Aroclor-1254	<1	10	—	10	SS	No TRV for reptiles. SBC (40 mg/kg) used for plants.
		Arsenic	<1 to 1	10.9	—	10.9	SS	No TRV for reptiles. SBC (10 mg/kg or 0.02 mg/L) used for plants.
		Benzo(a)anthracene	<1	9	—	9	SS	No TRV for plants, reptiles or birds.
		Benzo(b)fluoranthene	<1	4.2	—	4.2	SS	No TRV for plants, reptiles or birds.
		Benzo(g,h,i)perylene	<1	5.1	—	5.1	SS	Used benzo(a)pyrene values.
		Benzo(k)fluoranthene	<1	3.2	—	3.2	SS	Used benzo(a)pyrene values.

Table 7-19. (continued).

Site Number	Site Description and Size (sq. meters)	Contaminant of Potential Concern	Hazard Quotient	Maximum Concentration Detected (mg/kg)	95% UCL or Maximum Surface Soil Concentration	95% UCL or Maximum Subsurface Soil Concentration	Depth Detected[a]	Data Gaps[b]
		Cadmium	<1	7.37	—	7.37	SS	No TRV for reptiles. SBC (3 mg/kg or 0.1 mg/L) used for plants.
		Chromium III	<1 to 2	179	—	179	SS	No TRV for reptiles. SBC (1 mg/kg or 0.05 mg/kg) used for plants.
		Chrysene	<1	7.9	—	7.9	SS	No TRV for plants, reptiles or birds.
		Copper	≤1 to 20	1,900	—	1,900	SS	No TRV for reptiles. SBC (100 mg/kg or 0.05 mg/L) used for plants.
		Indeno(1,2,3-cd)pyrene	<1	4.6	—	4.6	SS	Used benzo(a)pyrene values.
		Lead	<1 to 20	725	—	725	SS	No TRV for reptiles. SBC (50 mg/kg or 0.02 mg/L) used for plants.
		Mercury	<1 to 2	1.97	—	1.97	SS	No TRV for reptiles. SBC (0.3 mg/kg or 0.005 mg/L) used for plants.
		Nickel	< to 3	85.1	—	85.1	SS	No TRV for reptiles. SBC (30 mg/kg or 0.5 mg/L) used for plants (HQ for plants only.).
		Pyrene	<1	24	—	24	SS	No TRV for plants, reptiles or birds.
		Selenium	<1	0.543	—	0.543	SS	No TRV for reptiles. SBC (1 mg/kg or 0.1 mg/L) used for plants.
		Silver	<1 to 10	19.4	—	19.4	SS	No TRV for reptiles or birds. SBC (2 mg/kg or 0.1 mg/L) used for plants. (HQ for plants only.)
		Zinc	<1 to 6	302	—	302	SS	No TRV for reptiles. SBC (50 mg/kg or 0.4 mg/L) used for plants.
CFA-15	Dry Well (CFA-674) 3.00E-01	Copper	<1	21.1	—	21.1	SS	No TRV for reptiles. SBC (100 mg/kg or 0.05 mg/L) used for plants.
		Lead	<1	15.7	—	15.7	SS	No TRV for reptiles. SBC (50 mg/kg or 0.02 mg/L) used for plants.
		Mercury	<1 to 1	0.42	—	0.42	SS	No TRV for reptiles. SBC (0.3 mg/kg or 0.005 mg/L) used for plants. (HQ for plants only.)

Table 7-19. (continued).

Site Number	Site Description and Size (sq. meters)	Contaminant of Potential Concern	Hazard Quotient	Maximum Concentration Detected (mg/kg)	95% UCL or Maximum Surface Soil Concentration	95% UCL or Maximum Subsurface Soil Concentration	Depth Detected[a]	Data Gaps[b]
CFA-17/47[e]	Fire Department Training Area, bermed and Fire Station Chemical Disposal 1.96E+03	Benzo(a)pyrene	<1	1.37	—	0.137	SS	No TRV for plants, reptiles or birds.
		Benzo(b)fluoranthene	<1	0.2	—	0.2	SS	No TRV for plants, reptiles or birds.
		Benzo(g,h,i)perylene	<1	0.16	—	0.16	SS	Used benzo(a)pyrene values.
		Xylene[f]	≤3 to 10	6.9	—	6.9	S	No TRV for reptiles or birds. SBC (100 mg/L) used for plants.
CFA-21	Fuel Tank at Nevada Circle (S by CFA-629) 7.00E+00	TPH	≤1 to 3	54,000	—	54,000	SS	No TRV for reptiles.
CFA-23	Fuel Oil Tank at CFA-641 1.11E+01	TPH	<1	100	—	100	SS	No TRV for reptiles.
CFA-24	Fuel Tank at Nevada Circle (S by CFA-629) 2.04E+01	TPH	<1	2,600	—	2,600	SS	No TRV for reptiles.
CFA-26	CFA-760 Pump Station Fuel Spills 1.12E+02	TPH	≤1 to ≤4	3,470	—	3,470	SS	No TRV for reptiles.
CFA-27	Fuel Oil Tank at CFA-669 9.28E+00	TPH	<1	1,100	—	1,100	SS	No TRV for reptiles.
CFA-28	Fuel Oil Tank at CFA-674 (west) 8.00E+01	TPH	<1	57.4	0.0	57.4	SS	No TRV for reptiles.
CFA-30	Fuel Oil Tank at CFA-665 2.08E+01	TPH	<1	76	0.0	76.0	SS	No TRV for reptiles.
CFA-31	Waste Oil Tank at CFA-754 2.52E+01	TPH	<1 to 1	5,610	5,610	—	SS	No TRV for reptiles.
		Xylene	<1	6.69	—	6.69	SS	No TRV for reptiles or birds. SBC (100 mg/L) used for plants.

Table 7-19. (continued).

Site Number	Site Description and Size (sq. meters)	Contaminant of Potential Concern	Hazard Quotient	Maximum Concentration Detected (mg/kg)	95% UCL or Maximum Surface Soil Concentration	95% UCL or Maximum Subsurface Soil Concentration	Depth Detected[a]	Data Gaps[b]
CFA-34	Diesel Tank at CFA-674 (south) 7.43E+00	TPH	<1	290	—	290	SS	No TRV for reptiles.
CFA-37	Diesel Tank at CFA-681 (south) 5.94E+00	TPH	<1	180	—	180	SS	No TRV for reptiles.
CFA-38	Fuel Oil Tank at CFA-683 7.56E+01	TPH	<1	427	—	427	SS	No TRV for reptiles.
CFA-40	Returnable Drum Storage (south of CFA-601) 5.40E+02	TPH	≤1 to 3	<625	—	625	S&SS	No TRV for reptiles.
CFA-41	Excess Drum Storage (south of CFA-674) 6.97E+03	TPH	<1 to 20	<1,000	1,000	1,000	S&SS	No TRV for reptiles.
CFA-43	Lead Storage Area 1.53E+04	Lead	≤1 to 70	36.7	36.7	—	S	No TRV for reptiles. SBC (50 mg/kg or 0.02mg/L) used for plants.
CFA-44	Spray Paint Booth Drain (CFA-654) 9.24E+00	Lead	<1 to 1	51.1	51.1	5.8	S&SS	No TRV for reptiles. SBC (50 mg/kg or 0.02 mg/L) used for plants.
CFA-45	Fuel Oil Tank (CFA-605W) 1.49E+00	TPH	<1	<1,000	1,000	1,000	S&SS	No TRV for reptiles.
CFA-48	Chemical Washout Area south of CFA-633 9.29E+00	Lead	<1	43.1	43.1	—	S	No TRV for reptiles. SBC (50 mg/kg or 0.02 mg/L) used for plants.
		Mercury	<1	0.18	0.18	—	S	No TRV for reptiles. SBC (0.3 mg/kg or 0.005 mg/L) used for plants.
CFA-51	Dry Well at north end of CFA-640 1.00E-01	Cadmium	<1 to 5	14.0	—	14.0	SS	No TRV for reptiles. SBC (3 mg/kg or 0.1 mg/L) used for plants. (HQ for plants only.)
		Copper	≤1 to 1	250	—	250	SS	No TRV for reptiles. SBC (100 mg/kg or 0.05 mg/L) used for plants. (HQ for plants only.)

Table 7-19. (continued).

Site Number	Site Description and Size (sq. meters)	Contaminant of Potential Concern	Hazard Quotient	Maximum Concentration Detected (mg/kg)	95% UCL or Maximum Surface Soil Concentration	95% UCL or Maximum Subsurface Soil Concentration	Depth Detected[a]	Data Gaps[b]
		Lead	<1	37.0	—	37.0	SS	No TRV for reptiles. SBC (50 mg/kg or 0.02 mg/L) used for plants.
		Selenium	<1	0.60	—	0.60	SS	No TRV for reptiles. SBC (1 mg/kg or 0.1 mg/L) used for plants. (HQ for plants only.)
		Zinc	<1 to 7	340	—	340	SS	No TRV for reptiles. SBC (50 mg/kg or 0.4 mg/L) used for plants.

a. S = surface, i.e., 0 to ≤ 0.5 ft
SS = subsurface, i.e., >1 to ≤ 0.5 ft

b. SBCs from Will and Suter 1995.

c. — = not calculated.

d. This is the average of two positive subsurface cadmium concentrations (2.0 and 2.3 mg/kg) at CFA-04

e. At CFA-17/47 organic compounds were calculated using maximum concentrations.

f. Xylene was detected at 10 ft bgs.

remaining concentrations and therefore drives the HQ. However, acetone is not expected to persist in the environment. The extent of contamination is from 0 to 10 ft.

CFA-04, pond near CFA-674, has HQs greater than 1.0 from exposure to metals and Aroclor-1254. The largest HQs resulted from exposures to cadmium, mercury, and vanadium. To a lesser extent, other contaminants of concern include arsenic, barium, chromium III, cobalt, copper, lead, nickel, and silver. The maximum concentrations of these contaminants were less than 2 times their respective background concentrations. The extent of contamination is from 0 to 7 ft.

CFA-05, CFA motor pool pond, has HQs greater than 1.0 from metals. The largest HQs resulted from exposures to cadmium, chromium III, and lead. The maximum cadmium concentration was 38.8 mg/kg with an HQ ranging from ≤ 1 to 10,000. The maximum chromium III concentration was 91.3 mg/kg with an HQ ranging from ≤1 to 1,000. The maximum lead concentration was 631 mg/kg with an HQ ranging from ≤1 to 1,000. To a lesser extent, other contaminants of concern include arsenic, barium, cobalt, copper, manganese, mercury, and nickel. The maximum arsenic concentration was 18.4 mg/kg. The maximum barium concentration was 434 mg/kg. The maximum cobalt concentration was 9.4 mg/kg. The maximum copper concentration was 342 mg/kg. The maximum manganese concentration was 767 mg/kg. The maximum mercury concentration was 1.2 mg/kg. The maximum nickel concentration was 37.1 mg/kg. The HQs ranged from ≤1 to 100 for copper; ≤1 to 80 for mercury; ≤1 to 20 for cobalt and manganese; ≤1 to 10 for nickel; and ≤1 to 1 for barium. Contamination is limited to the surface soil for arsenic, cadmium, chromium III, copper and mercury but extends to 10 ft for barium, cobalt, lead, manganese, and nickel.

CFA-06, lead shop (outside areas), had HQs greater than 1.0 from potential exposure to both arsenic and lead. The maximum arsenic concentration is 14.5 mg/kg with an HQ ranging from ≤ 1 to 10. The maximum lead concentration is 153, with an HQ ranging from ≤ 1 to 200. Contamination is limited to the surface soil.

CFA-08, sewage plant (CFA-691), septic tank (CFA-716), and drainfield, has HQs greater than 1.0 from exposure to metals. The largest HQs resulted from exposures to lead, mercury, and selenium. The HQs ranged from ≤2 to 30 for lead; ≤1 to 30 for mercury; and ≤ 2 to 20 for selenium. To a lesser extent, other metal contaminants of concern include arsenic, chromium III, copper, nickel, and silver. The HQs ranged from ≤1 to 10 for arsenic, copper, and nickel; ≤ 3 to 5 for silver; and < 1 to 2 for chromium. With the exception of selenium and silver, the maximum concentrations of the remaining metals are less than 2 times their respective background concentrations. Selenium is less than 5 times its background concentration. There is no background concentration for silver. The extent of contamination is between 0 and 10 ft.

CFA-10, transformer yard oil spills, has HQs greater than 1.0 from exposure to metals. The largest HQs resulted from exposures to cadmium, and lead. The HQs ranged from ≤1 to 2,000 for cadmium and ≤1 to 3,000 for lead. To a lesser extent, other metal contaminants of concern include antimony, arsenic, cobalt, copper, manganese, mercury, nickel, and zinc. The HQs ranged from <1 to 70 for copper and zinc; ≤2 to 30 for cobalt; ≤ 5 to 20 for manganese; <1 to 20 for nickel, < 1 to 8 for arsenic, and < 1 to 4 for antimony and mercury. The extent of contamination is in the surface soil.

CFA-12, two French Drains, (CFA-690) had exposures to pentachlorophenol; however, no TRVs are available for this contaminant.

CFA-13, Dry Well (south of CFA-640), had HQs greater than 1.0 from potential exposure to metals and pyrene. The largest HQ resulted from zinc, < 1 to 453. For other contaminants of concern, the HQs ranged from <1 to 33 for lead; ≤ 1 to 20 for copper, 4 for silver, and < 1 to 2 for chromium III, mercury, and pyrene.

CFA-15, Dry Well (CFA-674), had an HQ greater than 1.0 from potential exposure to copper (< 1 to 9). The HQ for mercury was 1.

CFA-17/47, fire department training area and fire station disposal, has an HQ greater than 1.0 from exposure to xylene (HQ ≤ 3 to 10). However, since this HQ results from one sample collected at 10 ft (3 m) bgs, this site is not anticipated to pose an ecological risk.

The following fuel tank and/or petroleum spill sites: CFA-23, CFA-24, CFA-27, CFA-28, CFA-29, CFA-30, CFA-34, CFA-37, CFA-38, and CFA-45 had HQs less than 1.0 for TPH. CFA-31 had an HQ less than or equal to 1.0 for TPH and an HQ less than 1 for xylene. The four petroleum sites that had HQs greater than 1.0 were CFA-21 and CFA-40, with HQs of 3.0, CFA-26, with an HQ of 4.0, and CFA-41, with an HQ of 20. The extent of contamination is between 1 and 10 ft. At CFA-21, CFA-26, and CFA-40, mammalian herbivores, including pygmy rabbits, and mammalian and avian insectivores are potentially at risk from TPH contamination.

At CFA-41, avian insectivores including black terns are potentially are risk from TPH contamination.

CFA-43, lead storage area, has an HQ greater than 1.0 from exposure to lead (HQ ≤ 1 to 70). Contamination is limited to the surface soil.

CFA-44, spray paint booth drain, has an HQ less than 1.0 from exposure to lead. Therefore, CFA-44 is eliminated as an ecological concern at WAG 4.

CFA-48, chemical washout area, has an HQ less than 1.0 from exposures to lead and mercury. Therefore, CFA-48 is eliminated as an ecological concern at WAG 4.

CFA-51, dry well at north end of CFA-640, has HQs greater than 1.0 for both cadmium, copper, and selenium for plants only; screening benchmark concentrations from Will and Sutter (1995) were used. The extent of contamination is between 1 and 2.5 ft. Due to the limited size of this site (1.0E-01 m^2) limited plants will be adversely affected. Therefore, CFA-51is eliminated as a concern in the ERA.

7.4.4 Discussion of Uncertainty

The WAG ERA, by definition, is a conservative approach to assess the potential for risk to ecological receptors from a particular WAG's contaminant sources. The WAG ERA incorporates levels of uncertainty that could either overestimate or underestimate the actual risk to these receptors. To compensate for potential uncertainties, the WAG ERA incorporates various factors that are designed to be conservative rather than result in a conclusion of no indication of risk when actual risk may exist. Regardless, uncertainties exist that could affect the estimation of true risk associated with WAG 4. These are summarized in Table 7-20.

Principal sources of uncertainty lie within the development of an exposure assessment and toxicity assessment. Uncertainties inherent in the exposure assessment are associated with estimation of receptor

Table 7-20. Sources and effects of uncertainties in the ecological risk assessment.

Uncertainty Factor	Effect of Uncertainty (Level of Magnitude)	Comment
Estimation of ingestion rates (soil and food)	May overestimate or underestimate risk (moderate)	Few intake (ingestion estimates used for terrestrial receptors are based on data in the scientific literature (preferably site-specific) when available. Food ingestion rates are calculated by using allometric equations available in the literature (Nagy 1987). Soil ingestion values are generally from Beyer et al. (1987).
Estimation of bioaccumulation and plant uptake factors	May overestimate or underestimate risk and the magnitude of error cannot be quantified (high).	Few bioaccumulation factors (BAFs) or plant uptake factors (PUFs) are available in the literature because they must be both contaminant- and receptor-specific. In the absence of more specific information, PUFs and BAFs for metals and elements are obtained from Baes et al. (1984), and for organic compounds, from Travis and Arms (1988).
Use of human health exposure concentrations Estimation of toxicity reference values	May overestimate (high) risk May overestimate (high) or underestimate (moderate) risk	Exposure concentrations were derived from data obtained as a product of biased sampling of WAG 4 sites. Samples were generally obtained from areas where contamination was believed to greatest. To compensate for potential uncertainties in the exposure assessment, various adjustment factors are incorporated to extrapolate toxicity from the test organism to other species.
Use of functional grouping	May overestimate (high) risk	Functional groups were designed as an assessment tool that would ensure that the ERA would address all species potentially present at the facility. A hypothetical species is developed using input values to the exposure assessment that represents the greatest exposure of the combined functional group members.
Site use factor	May overestimate (high) or underestimate (moderate) risk	Site use factor is a percentage of the site of concern compared to the home range. This is extrapolated from literature values and allometric equations, may vary from season to season and year to year depending on environmental conditions. It is highly uncertain.

ingestion rates, selection of acceptable HQs, estimation of site usage, and estimation of PUFs and BAFs. Additional uncertainties are associated with the depiction of site characteristics, the determination of the nature and extent of contamination, and the derivation of TRVs. These uncertainties will likely influence risk estimates.

At this level of the ERA, HQs greater than 1.0 tend to be from nonradionuclide contamination. This is explained in part by the methods used to determine toxicity values. For radionuclides, the TRVs are based on effects to populations, while for nonradionuclides, the TRVs are based on effects to individuals. As such, the nonradionuclide toxicity data is more conservative than the radionuclide toxicity data.

In relation to extrapolations between individuals and populations, it is difficult to accurately predict ecological effects of toxic substances because of the complexity of the ecosystem. Most toxicity information comes from laboratory studies of single contaminant impacts on single species. Hence, there is a great deal of uncertainty in extrapolating controlled laboratory results to complex field situations and from one species to another. Single contaminant studies cannot predict the interactions of multiple contaminants with each other and with the ecosystem. Additionally, interactions of organisms with the ecosystem are complex and not easily predicted. Arsenic and mercury are the most common nonradiological ecological risk drivers at WAG 4. These metals show "potential risk" even at background concentrations. Hence, any indication of concentrations above background for these two metals will result in a potential risk. The background concentrations used for screening are from Rood et al. (1995). These background concentrations can be used to eliminate potential contaminants that are clearly at background levels. As discussed in Rood et al. (1995), because of spatial variation in background concentrations due in part to differences in soil types, exceeding the background limits does not necessarily mean that the site is contaminated. As such, there is reason to suspect that some of the sites determined to have potential risks from arsenic and mercury may actually be background risks. Furthermore, the presence of arsenic at WAG 4 is likely to be unrelated to site activities since there are no known CFA processes that included arsenic.

A number of data gaps were identified in the course of the ecological risk analysis that will be addressed in the OU 10-04 ERA effort. Few data are available for the invertebrate populations at the INEEL. Invertebrates are important links in dietary exposure for wildlife. There are insufficient ecological and toxicological data to adequately characterize the contaminant effects in the invertebrate component of the ecosystem. Such uncertainty will propagate into some of the other endpoint compartments, in particular those representing mammalian, avian, and reptilian insectivores. At the OU 10-04 level, this data gap will be addressed to the extent possible.

There are a number of T/E or sensitive species that could occur at WAG 4. In some cases, they are known to exist in close proximity to WAG 4 sites. The lack of information concerning the presence or absence of T/E and/or sensitive species in the vicinity of INEEL facilities, and at the INEEL in general, has been previously identified as an acceptable data gap.

Ecotoxicological data is recognized as one of the major uncertainties in ERA. As with human health risk assessments, the TRVs are updated as new information is available for use in INEEL ERAs. This is an ongoing effort that will continue throughout the ERA process at the INEEL. Several contaminants (e.g., arsenic) appear to be an ecological risk at soil concentrations that are typical of background concentrations for these metals at similar sites. However, they fail the background screen at the INEEL. To permit a more accurate assessment, these contaminants will be reviewed during the 10-04 ERA. At this time, a greater discussion on issues of background and these contaminants will be included.

Many of these uncertainties will be difficult to reduce without obtaining extensive site-specific information. As part of the 10-04 ERA effort, site-specific ecological sampling has been proposed to provide information concerning movement of contaminants through the ecosystem. This sampling will be directed at eliminating some of the uncertainty that is present in the WAG ERA. Currently, an assessment of the uncertainty of using functional groups is being performed, and it has been proposed that a combination of functional groups and individual species be used for the 10-04 ERA. This should allow a better understanding of the results of the risk assessment. The results of the WAG 4 ERA are summarized in Table 7-21 and sites and COPCs shown to have potential risk for ecological receptors are listed in Table 7-22.

Table 7-21. Summary of ecological risk assessment screening steps used at WAG 4 sites.

Operable Unit	Site Code	Site Description	Site Screening Step[a]	EBSL & Bkgd Screening Step[b]	HQ Screening Step[c]	Pathway to Species of Concern[d,e]	Other Rationale/Final Comments
OU 4-01	CFA-09	Central Gravel Pit	E	NA	NA	NA	There is no source.
	CFA-11	French Drain (containing 5 in. shell) N. of CFA-633	E	NA	NA	NA	There is no source.
OU 4-02	CFA-13	Dry Well (South of CFA-640)	C	C	M	ss	October 1997 data indicate that soil at 6 ft below grade chromium ranges from 9.89 to 11.7 mg/kg and 1,1,2-trichloro-1,2,2-trifluoroethane ranges from 0.004 to 0.005 mg/kg. Several metals, VOCs, and PAHs exceeded EBSLs. HQs <1: Sb, As, PCBs, BaA, BbF, BghiP, BkF, chrysene, I(1,2,3-cd)P, Cd and Se; HQs <1 to 2: CrIII, Hg and pyrene, HQ = 4: Ag; HQ <1 to 33: Pb; and HQ <1 to 453: Zn.
	CFA-14	Two Dry Wells (CFA-665)	E	NA	NA	NA	No data are available. The wells were not located.
	CFA-15	Dry Well (CFA-674)	C/R	M	E	NA	The source was removed in 1997. November 1997 data indicate that soil samples from 8 ft below grade contained Cu, Pb and Hg at concentrations above background and EBSLs. Pb and Hg had HQs <1 and Cu had an HQ <9.
	CFA-16	Dry Well (South of CFA-682 Pumphouse)	E	NA	NA	NA	There is no source.
OU 4-03	CFA-18	Fire Department Training Area, Oil Storage Tank	E	NA	NA	NA	There is no source.
	CFA-19	Gasoline Tanks (2) East of CFA-606	E	NA	NA	NA	There is no source.
	CFA-20	Fuel Oil Tank at CFA-609 (CFA-732)	E	NA	NA	NA	There is no source.
	CFA-21	Fuel Tank at Nevada Circle 1 (South by CFA-629)	C	T	T	ss	The source was removed in 1991. TPH was initially identified. The maximum TPH concentration was 54,000 mg/kg, which exceeded the EBSL. The HQ for TPH was <3 and CFA-21 was retained as an ecological risk site.

Table 7-21. (continued).

Operable Unit	Site Code	Site Description	Site Screening Step[a]	EBSL & Bkgd Screening Step[b]	HQ Screening Step[c]	Pathway to Species of Concern[d,e]	Other Rationale/Final Comments
	CFA-22	Fuel Oil Tank at CFA-640	C/E	NA	NA	NA	The source was removed in 1991. TPH and VOCs were initially identified. The maximum TPH concentration was 8,400 mg/kg, but contamination was below 10 ft; therefore, CFA-22 was eliminated as an ecological risk site.
	CFA-23	Fuel Oil Tank at CFA-641	C	T & V	E	NA	The source was removed in 1990. TPH and toluene were initially identified. Toluene did not exceed the EBSL. The maximum TPH concentration was 100 mg/kg, which exceeded the EBSL. The HQ is <1 therefore, CFA-23 was eliminated as an ecological risk site.
	CFA-24	Fuel Tank at Nevada Circle 2 (South by CFA-629)	C	T	E	NA	The source was removed in 1991. TPH was initially identified. The maximum TPH concentration was 2600 mg/kg at CFA-24. The HQ is <1 therefore, CFA-24 was eliminated as an ecological risk site.
	CFA-25	Fuel Oil Tank at CFA-656 (north side)	C	E	NA	NA	The source was removed in 1990. TPH was initially identified but the maximum TPH concentration was 20 mg/kg, which did not exceed the EBSL. Therefore, CFA-25 was eliminated as an ecological risk site.
	CFA-27	Fuel Oil Tank at CFA-669	C	T & V	E	NA	The source was removed in 1990. TPH and BTEX were initially identified. The maximum TPH concentration was 1,100 mg/kg, which exceeded the EBSL. The HQ for TPH is <1 therefore, CFA-27 was eliminated as an ecological risk site.
	CFA-28	Fuel Oil Tank at CFA-674 (West)	C	T	E	NA	The source was removed in 1992. TPH was initially identified. The maximum TPH concentration was 57.4 mg/kg, which exceeded the EBSL. The HQ for TPH is <1 therefore, CFA-28 was eliminated as an ecological risk site.
	CFA-29	Fuel Oil Tank at CFA-664	C	E	NA	NA	The source was removed in 1990. TPH was initially identified. The maximum TPH concentration was 9 mg/kg, which did not exceed the EBSL. Therefore, CFA-29 was eliminated as ecological risk site.

Table 7-21. (continued).

Operable Unit	Site Code	Site Description	Site Screening Step[a]	EBSL & Bkgd Screening Step[b]	HQ Screening Step[c]	Pathway to Species of Concern[d,e]	Other Rationale/Final Comments
	CFA-30	Fuel Oil Tank at CFA-665	C	T	E	NA	The source was removed in 1989. TPH and ethylbenzene were initially identified. The maximum TPH concentration was 76 mg/kg, which exceeded the EBSL. Ethylbenzene did not exceed the EBSL. The HQ for TPH is <1, therefore, CFA-30 was eliminated as an ecological risk site.
	CFA-31	Waste Oil Tank at CFA-754	C	V & T	T	ss	The source was removed in 1992. TPH, ethylbenzene, toluene, xylene and TCE were initially identified. The maximum TPH concentration was 5,610 mg/kg, which exceeded the EBSL. Ethylbenzene, toluene, xylene and TCE did not exceed EBSLs. The HQ for xylene is <1 and for TPH is 1. Therefore, CFA-31 was retained an ecological risk site.
	CFA-32	Fuel Oil Tank at CFA-667 (North)	C	E	NA	NA	The source was removed in 1990. TPH was initially identified. The maximum TPH concentration was 30 mg/kg at CFA-32, which did not exceed the EBSL. Therefore, CFA-32 was eliminated as an ecological risk site.
	CFA-33	Fuel Oil Tank at CFA-667 (South)	E	NA	NA	NA	The source was removed in 1990. No contaminants were identified.
	CFA-34	Diesel Tank at CFA-674 (South)	C	T	E	NA	The source was removed in 1990. TPH was initially identified. The maximum TPH concentration was 290 mg/kg, which exceeded the EBSL. The HQ for TPH is <1, therefore CFA-34 was eliminated as an ecological risk site.
	CFA-35	Sulfuric Acid Tanks at CFA-674 (West)	C	E	NA	NA	The source was removed in 1989. Metals were initially identified but did not exceed EBSLs. Therefore, CFA-35 was eliminated as an ecological risk site.
	CFA-36	Gasoline Tanks at CFA-680	E	NA	NA	NA	The source was removed in 1990. No contaminants were identified.

Table 7-21. (continued).

Operable Unit	Site Code	Site Description	Site Screening Step[a]	EBSL & Bkgd Screening Step[b]	HQ Screening Step[c]	Pathway to Species of Concern[d,e]	Other Rationale/Final Comments
	CFA-37	Diesel Tank at CFA-681 (South Side)	C	T	E	NA	The source was removed in 1990. TPH was initially identified. The maximum TPH concentration was 180 mg/kg, which exceeded the EBSL. The HQ for TPH is <1, therefore, CFA-37 was eliminated as an ecological risk site.
	CFA-38	Fuel Oil Tank, CFA-683	C	T	E	NA	The source was removed in 1992. TPH was initially identified. The maximum TPH concentration was 427 mg/kg, which exceeded the EBSL. The HQ for TPH is <1, therefore, CFA-38 was eliminated as an ecological risk site.
	CFA-45	Fuel Oil Tanks (CFA-605W)	C	E	NA	NA	The source was removed in 1991. TPH & BTEX were initially identified. The maximum TPH concentration was <1,000 mg/kg, below 10 ft which exceeded the EBSL. The HQ was <1. Therefore, CFA-45 was eliminated as an ecological risk site.
OU 4-04	CFA-39	Drum Dock (CFA-771)	E	NA	NA	NA	No source.
	CFA-40	Returnable Drum Storage—South of CFA-601	C	T	T	s & ss	TPH was initially identified. The maximum TPH was <625 mg/kg (the detection limit of the screening method) which exceeded the EBSL. The HQ was 3. Therefore, CFA-40 was retained as an ecological risk site.
	CFA-41	Excess Drum Storage (South of CFA-674)	C	T	T	s & ss	TPH, BTEX, naphthalene & methylnaphthalene were initially identified. In May 1995, the maximum TPH was >1000 mg/kg, which was the detection limit of the screening method which exceeded the EBSL. The HQ was 20. Therefore, CFA-41 was retained as an ecological risk site.

Table 7-21. (continued).

Operable Unit	Site Code	Site Description	Site Screening Step[a]	EBSL & Bkgd Screening Step[b]	HQ Screening Step[c]	Pathway to Species of Concern[d,e]	Other Rationale/Final Comments
OU 4-05	CFA-04	Pond (CFA-674)	C & R	M, P & R	M	s & ss	Metals, asbestos, VOCs, SVOCs, radionuclides and PCBs were initially identified; Ba, Cd, CrIII, Co, Cu, Pb, Hg, Ni, nitrate, Ag, Pa-234m, Ra-226, Sr-90, Th-234, U-234, U-235, U-238 & Aroclor-1254 exceeded EBSLs. HQs are: Ba ≤1, Cd <1000, CrIII <2, Co <20, Cu <60, Pb <90, Hg >30,000, Ni <50, nitrate <1, Ag <6, V <200, PCBs <1. Samples from 0–10 ft contained 3.1 to 22.4 mg/kg As, 0.12 to 439 mg/kg Hg, 0.651 to 22.6 pCi/g U-234 and 0.73 to 35 pCi/g U-238. CFA-04 is retained in the ERA.
	CFA-17/47	Fire Department Training Area, bermed/ Fire Station Chemical Disposal	C	V, S & M	V & S	s & ss	CFA-17 & CFA-47 are evaluated as 1 site. VOCs, SVOCs, PCBs & metals were initially identified; BaP, BbF, BghiP, and xylene exceeded EBSLs. HQs are: BaP, BbF, and BghiP <1and xylene <10. September 1997 samples indicated that the soil contained 0.16 mg/kg benzo(g,h,i)perylene and from 0.0252 to 0.14 mg/kg phenanthrene. (There are no background concentrations for these contaminants.) Therefore, CFA-17/47 are retained in the ERA.
	CFA-50	Shallow Well east of CFA-654	C/E	NA	NA	NA	Removal action in July 1995. Three samples collected from 6.25 ft to 7.5 ft contain 3,050 mg/kg Al, 57,600 mg/kg Ca, 25.1 mg/kg Pb & 0.36 mg/kg Se above background concentrations. Al & Ca were *eliminated from the human health risk assessment.* Pb and Se were less than residential screening level or had an HQ <1, respectively. Therefore, CFA-50 was eliminated as an ecological risk site.
OU 4-06	CFA-06	Lead Shop (outside areas)	C	C	M	s	The source was removed in 1996. Soil samples analyzed between 0 and 1 ft contained from 10.4 to 14.5 mg/kg As and from 10.4 and 153 mg/kg Pb, which exceeded EBSLs. HQs are: As<10 and Pb <200. CFA-06 was retained as an ecological risk site.
	CFA-43	Lead Storage Area	C	M	M	s	Metals were initially identified; Pb exceeded the EBSL. The HQ is: Pb <70. Therefore, CFA-43 is retained in the ERA.

Table 7-21. (continued).

Operable Unit	Site Code	Site Description	Site Screening Step[a]	EBSL & Bkgd Screening Step[b]	HQ Screening Step[c]	Pathway to Species of Concern[d,e]	Other Rationale/Final Comments
	CFA-44	Spray Paint Booth Drain (CFA-654)	C	M	E	NA	Metals were initially identified; Pb exceeded EBSL. HQ is: Pb <1. Therefore, CFA-44 was eliminated in the ERA.
OU 4-07	CFA-07	French Drain (E/S of CFA-633)	E	NA	NA	NA	No exposure pathway to ecological receptors because contaminants are >12 ft below grade.
	CFA-12	Two French Drains (CFA-690)	C & R	S, P & R	S	ss	VOCs, SVOCs, PCBs & radionuclides were initially identified; PCP exceeded the EBSL but there is no TRV for this COPC. CFA-12 is retained in the ERA.
	CFA-48	Chemical Washout Area South of CFA-633	C	M	E	NA	Metals were initially identified. Pb and Hg exceeded EBSLs but the HQs were <1. Therefore, CFA-48 was eliminated in the ERA.
OU 4-08	CFA-08	Sewage Plant (CFA-691), Septic Tank (CFA-716), and Drain Field	C & R	V, S, P, M & R	M	s & ss	VOCs, SVOCs, PCBs, metals & radionuclides were initially identified; Aroclor-1254, chloromethane, BaP, As, CrIII, Cu, Pb, Hg, Ni, Se, and Ag exceeded EBSLs. HQs are: As <10, Cr <2, Cu <10, Pb <30, Hg <30, Ni <10, Se <20, Ag <5, BaP <1 and PCBs <1 therefore, CFA-08 is retained in the ERA.
	CFA-49	Hot Laundry Drain Pipe	R	E	NA	NA	Radionuclides were initially identified but did not exceed EBSLs. Contaminants were detected in soil samples from 26-5 to 27.0 ft below grade.
OU 4-09	CFA-10	Transformer Yard Oil Spills	C	M & P	M	s	Metals & PCBs were initially identified; Sb, As, Cd, CrIII, Cu, Pb, Hg, Ni, Ag, Zn & Aroclor-1254 exceeded EBSLs. HQs are: Sb <4, As <8, Cd <2000, Co <30, Cr <1, Cu <70, Pb <3000, Hg <4, Ni <20, Zn <70, and PCBs <1. A maximum concentration of 3,300 mg/kg Pb was detected between 0 and 0.5 ft below grade. Therefore, CFA-10 is retained in the ERA.
	CFA-26	CFA-760 Pump Station Fuel Spill	C	T	T	ss	The source was removed in 1986. VOCs, SVOCs and TPH were initially identified. The maximum TPH was 3,470 mg/kg which exceeded the EBSL. The HQ for TPH is <4. Therefore, CFA-26 is retained as an ecological risk site.

Table 7-21. (continued).

Operable Unit	Site Code	Site Description	Site Screening Step[a]	EBSL & Bkgd Screening Step[b]	HQ Screening Step[c]	Pathway to Species of Concern[d,e]	Other Rationale/Final Comments
	CFA-42	Tank Farm Pump Station Spills	C	E	NA	NA	The source was removed in 1997. VOCs, SVOCs & TPH were initially identified. Minor contamination remains below 10 ft. Therefore, CFA-42 is eliminated in the ERA.
	CFA-46	Cafeteria Oil Tank Spill (CFA-721)	E	NA	NA	NA	No exposure pathway to ecological receptors because contaminants are >10 ft below grade.
OU 4-10	CFA-01	Landfill I	NA	NA	NA	NA	See OU 4-12 below.
OU 4-11	CFA-05	Motor Pool Pond	C & R	V & M	V &M	s & ss	VOCs, PCBs, metals & radionuclides were initially identified; As, Ba, Cd, CrIII, Co, Cu, Pb, Mn, Hg, Ni, and 4-methyl-2-pentanone exceeded EBSLs. HQs are: As <20, Ba=1, Cd <10,000, Co <20, Cu <100, Pb <1,000, Mn <20, Hg <80, and Ni <10. There is no TRV for 4-methyl-2-pentanone. Therefore, CFA-05 is retained in the ERA.
OU 4-12	CFA-01	Landfill I	C	M, S&V	M & S	ss	Miscellaneous wastes possibly containing VOCs, SVOCs, TPH, metals, asbestos & PCBs were initially identified. Several VOCs, SVOCs and metals exceeded EBSLs. HQs are: BaP <2, BbF <1, BghiP <1, BkF <1, CrIII <2, chrysene <1, Cu <30, I(1,2,3-cd)P <1, Pb <100, Ag <4, and Zn <30. Therefore, CFA-01 is retained in the ERA.
	CFA-02	Landfill II	C	V, S & M	M & S	s & ss	Miscellaneous wastes possibly containing VOCs, SVOCs, TPH, metals, asbestos & PCBs were initially identified. TPH was not analyzed; 2-methylnaphthalene, 4-methyl-2-pentanone, acetone, BaP, BbF, BghiP, BkF, chrysene, DahA, dibenzofuran, I(1,2,3cd) P, PCP, As, Pb & Hg exceeded EBSLs. HQs are: 2-methylnaphthalene, BaP, BghiP, chrysene, DahA, I(1,2,3-cd)P <1; acetone <20, BbF = 1, BkF <2, As <20, Pb <700, Hg <5. There are no TRVs for 4-methyl-2-pentanone, dibenzofuran or pentachlorophenol. Therefore, CFA-02 is retained in the ERA.

Table 7-21. (continued).

Operable Unit	Site Code	Site Description	Site Screening Step[a]	EBSL & Bkgd Screening Step[b]	HQ Screening Step[c]	Pathway to Species of Concern[d,e]	Other Rationale/Final Comments
	CFA-03	Landfill III	C	E	NA	NA	Miscellaneous wastes possibly containing VOCs, SVOCs, TPH, metals, asbestos, PCBs & radionuclides were initially identified. Although Pb and Se exceeded the EBSLs, Pb only slightly exceeded background (17.3 mg/kg v. 17 mg/kg) and the Se concentration was identified by the analytical laboratory but may not be present. Therefore, CFA-03 was eliminated as an ecological risk site.
OU 4-13	CFA-51	Dry Well at North end of CFA-640	C & R	R & M	M	ss	Metals including Al, As, Ba, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Ni, Na, V, Zn & Cs-137 were initially identified. Cd, Cu, & Pb, exceeded EBSLs; only Cd & Cu exceeded HQs. HQs are Cd ≤3 and Cu ≤1 (for plants only). Due to the limited size and number of plants that would be affected, CFA-51 is eliminated in the ERA.
	CFA-52	Diesel Fuel UST (CFA-730) at Bldg. CFA-613 Bunkhouse	C/E	NA	NA	NA	TPH, TCA & PCE were initially identified; the data were evaluated and contamination was detected below 10 ft. Therefore, CFA-52 was eliminated as an ecological risk site.

a. = See Tables 7-2 & 7-3

b. = See Tables 7-8, 7-9 & 7-10

c. = See Table 7-19

E = eliminated
NA = not applicable
R = retained for radiological source
C = retained for chemical source:
M = retained for metal source
S = retained for SVOC source
T = retained for TPH source
V = retained for VOC source
U = retained for many unknown sources

d. See Table 7-19. For species of concern, see Appendix K.

e. ss = subsurface soil pathway.
s = surface soil pathway.

Table 7-22. Summary of the sites with potential for posing risk to ecological receptors.

Site Number	Site Description and Size (sq. meters)	Contaminant of Potential Concern	Hazard Quotient
CFA-01	Landfill I 4.30E+04	Benzo(a)pyrene	<1 to 2
		Chromium III	<1 to 2
		Copper	<1 to 30
		Lead	≤1 to 100
		Silver	≤1 to 4
		Zinc	≤1 to 30
CFA-02	Landfill II 7.07E+05	4-methyl-2-pentanone	NA
		Acetone	≤1 to 20
		Arsenic	≤1 to 20
		Benzo(b)fluoranthene	<1 to 1
		Benzo(k)fluoranthene	<1 to 2
		Dibenzofuran	NA
		Lead	≤1 to 700
		Mercury	≤1 to 5
		Pentachlorophenol	NA
CFA-04	Pond near CFA-674 6.88E+03	Barium	≤1 to 3
		Cadmium	≤1 to 1,000
		Chromium III	<1 to 2
		Cobalt	≤1 to 20
		Copper	≤1 to 60
		Lead	≤1 to 90
		Mercury	<1 to 30,000
		Nickel	<1 to 50
		Silver	<1 to 6
		Vanadium	≤2 to 200
CFA-05	Motor Pool Pond 7.43E+03	4-methyl-2-pentanone	NA
		Arsenic	≤1 to 20
		Barium	<1 to 1
		Cadmium	≤1 to 10,000

Table 7-22. (continued).

Site Number	Site Description and Size (sq. meters)	Contaminant of Potential Concern	Hazard Quotient
		Chromium III	≤1 to 1,000
		Cobalt	≤2 to 20
		Copper	≤1 to 100
		Lead	≤1 to 1,000
		Manganese	≤1 to 20
		Mercury	≤1 to 80
		Nickel	≤1 to 10
CFA-06	Lead Shop (outside areas) 2.5E+03	Arsenic	≤1 to 10
		Lead	≤1 to 200
CFA-08	Sewage Plant (CFA-691), Septic Tank (CFA-716), and Drainfield 1.85E+04	Arsenic	≤1 to 10
		Chloromethane	NA
		Chromium III	<1 to 2
		Copper	≤1 to 10
		Lead	≤2 to 30
		Mercury	≤1 to 30
		Nickel	≤1 to 10
		Selenium	≤2 to 20
		Silver	≤3 to ≤5
CFA-10	Transformer Yard Oil Spills 8.08E+02	Antimony	<1 to 4
		Arsenic	<1 to 8
		Cadmium	≤1 to 2,000
		Cobalt	≤2 to 30
		Copper	<1 to 70
		Lead	<1 to 3,000
		Manganese	≤ 5 to 20
		Mercury	<1 to 4
		Nickel	<1 to 20
		Zinc	<1 to 70

Table 7-22. (continued).

Site Number	Site Description and Size (sq. meters)	Contaminant of Potential Concern	Hazard Quotient
CFA-12	Two French Drains (CFA-690) 1.34E+01	Pentachlorophenol	NA
CFA-13	Dry Well (South of CFA-640)	Chromium III	<1 to 2
		Copper	≤1 to 20
		Lead	<1 to 33
		Mercury	<1 to 2
		Pyrene	<1 to 2
		Silver	4
		Zinc	<1 to 453
CFA-15	Dry Well (CFA-674)	Copper	<1 to 9
		Mercury	1
CFA-17/47	Fire Department Training Area, bermed and Fire Station Chemical Disposal 1.96E+03	Xylene	≤3 to 10
CFA-21	Fuel Tank at Nevada Circle (S by CFA-629) 7.00E+00	TPH	<1 to 3
CFA-26	CFA-760 Pump Station Fuel Spills 1.12E+02	TPH	≤1 to ≤4
CFA-31	Waste Oil Tank at CFA-754 2.52E+01	TPH	<1 to 1
CFA-40	Returnable Drum Storage (south of CFA-601) 5.40E+02	TPH	<1 to 3
CFA-41	Excess Drum Storage (south of CFA-674) 6.97E+03	TPH	<1 to 20
CFA-43	Lead Storage Area 1.53E+04	Lead	≤1 to 70
CFA-51	Dry Well at north end of CFA-640 1.00E-01	Cadmium	<1 to 5
		Copper	<1 to 1
		Selenium	<1 to 1

NA = not assessed; no TRV.

7.5 Subsequent Screening

Of the sites remaining after the WAG ERA HQ screening step all have nonradiological contamination and none have radiological contamination with HQ's greater than the target value.

Additional screenings and discussion are appropriate at this stage of the WAG ERA process to use a weight of evidence approach for the further elimination of sites and contaminants for consideration in the FS process. This type of evaluation will eliminate unnecessary and undesirable remediations for ecological receptors based on the following rationale.

- Contaminant concentrations—For the ERA, data values calculated for the BRA for the human health risk assessment were used when available. For those concentrations determined in the human health risk assessment (for the sites identified in Table 7-11) the maximum was generally used to estimate exposure-point concentrations except as noted.

- Modeling Conservatism—The exposure scenario used for ecological receptors assumes that the fences are down and the site has a viable habitat that is completely accessible to receptors. However, some sites of concern at CFA are currently fenced. Both the fence and the activities associated with this currently active facility should limit the exposure of receptors to much less than that model in the ERA. Additionally, (with some exceptions [particularly sites with water sources]) some of these sites are gravel and unsuitable habitat at the present time and would not provide any special attraction to ecological receptors.

- Parameter Conservatism—It is accepted in the risk assessment process that the many of the input parameters are developed to be conservatively protective of the receptors. Particularly, based on limited knowledge and the uncertainty of extrapolating to multiple species, TRVs development is very conservative. This is particularly true for naturally occurring metals, which can vary greatly across regions.

Based on this rationale, an additional screening was determined appropriate for the WAG 4 sites as agreed upon in a March 19, 1998 meeting between DOE-ID, EPA and IDHW. Contaminants are eliminated as a concern if the exposure point concentration exceeds 10x the background value. For those contaminants that have no site-specific background the mean for the western states presented in Shacklette and Boerngen (1984) or other sources was considered acceptable. Results of this screening are presented in Table 7-23.

This screening resulted in eliminating two sites (CFA-06 and CFA-15). The remaining 16 sites (CFA-01, CFA-02, CFA-04, CFA-05 CFA-08, CFA-10, CFA-12, CFA-13, CFA-17/47, CFA-21, CFA-26, CFA-31, CFA-40, CFA-41, CFA-43, and CFA-51) will be evaluated further in the FS.

7.6 Transition to Sitewide ERA

This WAG ERA represents the second phase of the four-phased approach to ERA presented in Section 7.1 (see Figure 7-1). The approach applies an iterative, "tiered" process in which preliminary assessments, based on conservative assumptions, support progressively more refined assessments (Maughn 1993; Opresko et al. 1995; Levin et al. 1989).

The first phase includes a data review and either a SLERA or EDGA, which is a "pre-assessment" performed at the WAG level. The pre-assessment (1) reduces the number of contaminants and sites to be

Table 7-23. Results of WAG 4 ecological contaminant screening against 10x INEEL background concentrations.

Site Number	Site Description and Size (sq. meters)	Contaminant of Potential Concern	Hazard Quotient	Maximum Concentration (mg/kg)	10x INEEL Background* (mg/kg)	Comment	Retain COPC?
CFA-01	Landfill I 4.30E+04	Benzo(a)pyrene	<1 to 2	0.89	NA	No background	YES
		Chromium III	<1 to 2	53	330	<10x background	No
		Copper	<1 to 30	73.4	220	<10x background	No
		Lead	≤1 to 100	38	170	<10x background	No
		Silver	≤1 to 4	19.5	NA	No background	YES
		Zinc	≤1 to 30	230	1500	<10x background	No
CFA-02	Landfill II 7.07E+05	4-methyl-2-pentanone	NA	0.02	NA	No background	YES
		Acetone	≤1 to 20	5.8	NA	No background	YES
		Arsenic	≤1 to 20	16	58	<10x background	No
		Benzo(b)fluoranthene	<1 to 1	0.89	NA	No background	YES
		Benzo(k)fluoranthene	<1 to 2	1.2	NA	No background	YES
		Dibenzofuran	NA	0.039	NA	No background	YES
		Lead	≤1 to 700	210	170	>10x background	YES
		Mercury	≤1 to 5	0.08	0.5	<10x background	No
		Pentachlorophenol	NA	0.074	NA	No background	YES
CFA-04	Pond near CFA-674 6.88E+03	Barium	≤1 to 3	530	3,000	<10x background	No
		Cadmium	≤1 to 1,000	3.4	22	<10x background	No
		Chromium III	<1 to 2	100	330	<10x background	No
		Cobalt	≤1 to 20	10	110	<10x background	No

Table 7-23. (continued).

Site Number	Site Description and Size (sq. meters)	Contaminant of Potential Concern	Hazard Quotient	Maximum Concentration (mg/kg)	10x INEEL Background* (mg/kg)	Comment	Retain COPC?
		Copper	≤1 to 60	140	220	<10x background	No
		Lead	≤1 to 90	42.4	170	<10x background	No
		Mercury	<1 to 30,000	439	0.5	>10x background	YES
		Nickel	<1 to 50	160	350	<10x background	No
		Silver	<1 to 6	31	NA	No background	YES
		Vanadium	≤2 to 200	46	450	<10x background	No
CFA-05	Motor Pool Pond 7.43E+03	4-methyl-2-pentanone	NA	0.065	NA	No background	YES
		Arsenic	≤1 to 20	18.4	58	<10x background	No
		Barium	<1 to 1	434	3,000	<10x background	No
		Cadmium	≤1 to 10,000	38.8	22	>10x background	YES
		Chromium III	≤1 to 1,000	91.3	330	<10x background	No
		Cobalt	≤2 to 20	9.4	110	<10x background	No
		Copper	≤1 to 100	342	220	>10x background	YES
		Lead	≤1 to 1,000	631	170	>10x background	YES
		Manganese	≤1 to 20	767	4,900	<10x background	No
		Mercury	≤1 to 80	1.2	0.5	>10x background	YES
		Nickel	≤1 to 10	37.1	350	<10x background	No
CFA-06	Lead Shop (outside areas) 2.50E+03	Arsenic	≤1 to 10	14.5	58	<10x background	No
		Lead	≤1 to 200	153	170	<10x background	No

Table 7-23. (continued).

Site Number	Site Description and Size (sq. meters)	Contaminant of Potential Concern	Hazard Quotient	Maximum Concentration (mg/kg)	10x INEEL Background* (mg/kg)	Comment	Retain COPC?
CFA-08	Sewage Plant (CFA-691), Septic Tank (CFA-716), and Drainfield 1.85E+04	Arsenic	≤1 to 10	14.1	58	<10x background	No
		Chloromethane	NA	0.005	NA	No background	YES
		Chromium III	<1 to 2	77.6	330	<10x background	No
		Copper	≤1 to 10	33.0	220	<10x background	No
		Lead	≤2 to 30	18	170	<10x background	No
		Mercury	≤1 to 30	0.51	0.5	>10x background	YES
		Nickel	≤1 to 10	38	350	<10x background	No
		Selenium	≤2 to 20	1.4	2.2	<10x background	No
		Silver	≤3 to ≤5	24.1	NA	No background	YES
CFA-10	Transformer Yard Oil Spills 8.08E+02	Antimony	<1 to 4	9.5	48	<10x background	No
		Arsenic	<1 to 8	11.6	58	<10x background	No
		Cadmium	≤1 to 2,000	7.3	22	<10x background	No
		Cobalt	≤2 to 30	15.7	110	<10x background	No
		Copper	<1 to 70	259	220	>10x background	YES
		Lead	<1 to 3,000	3,300	170	>10x background	YES
		Manganese	≤ 5 to 20	509	4,900	<10x background	No
		Mercury	<1 to 4	0.09	0.5	<10x background	No
		Nickel	<1 to 20	111	350	<10x background	No
		Zinc	<1 to 70	1,150	1,500	<10x background	No

Table 7-23. (continued).

Site Number	Site Description and Size (sq. meters)	Contaminant of Potential Concern	Hazard Quotient	Maximum Concentration (mg/kg)	10x INEEL Background* (mg/kg)	Comment	Retain COPC?
CFA-12	Two French Drains (CFA-690) 1.34E+01	Pentachlorophenol	NA	0.25	NA	No background	YES
CFA-13	Dry Well (South of CFA-640) 2.50E+01	Chromium III	<1 to 2	179	330	<10x background	No
		Copper	≤1 to 20	1,900	220	>10 background	YES
		Lead	<1 to 33	725	170	>10 background	YES
		Mercury	<1 to 2	1.97	0.5	>10 background	YES
		Pyrene	<1 to 2	24	NA	No background	YES
		Silver	4	19.4	NA	No background	YES
		Zinc	<1 to 453	302	1500	<10x background	No
CFA-15	Dry Well (CFA-674) 3.00E-01	Copper	<1 to 9	21.1	220	<10x background	No
		Mercury	1	0.42	0.5	<10x background	No
CFA-17/47[a]	Fire Department Training Area, bermed and Fire Station Chemical Disposal 1.96E+03	Xylene[b]	≤3 to 10	6.9	NA	No background	YES
CFA-21	Fuel Tank at Nevada Circle (S by CFA-629) 7.00E+00	TPH	<1 to 3	54,000	NA	No background	YES

Table 7-23. (continued).

Site Number	Site Description and Size (sq. meters)	Contaminant of Potential Concern	Hazard Quotient	Maximum Concentration (mg/kg)	10x INEEL Background* (mg/kg)	Comment	Retain COPC?
CFA-26	CFA-760 Pump Station Fuel Spills 1.12E+02	TPH	≤1 to ≤4	3,470	NA	No background	YES
CFA-31	Waste Oil Tank at CFA-754 2.52E+01	TPH	<1 to 1	5,610	NA	No background	YES
CFA-40	Returnable Drum Storage (south of CFA-601) 5.40E+02	TPH	<1 to 3	625	NA	No background	YES
CFA-41	Excess Drum Storage (south of CFA-674) 6.97E+03	TPH	<1 to 20	<1,000	NA	No background	YES
CFA-43	Lead Storage Area 1.53E+04	Lead	≤1 to 70	180	170	>10x background	YES
CFA-51	Dry Well at north end of CFA-640 1.00E-01	Cadmium	<1 to 5	14.0	22	<10x background	No
		Copper	<1 to 1	250	220		YES
		Selenium	<1 to 1	0.60	2.2	<10x background	No

a. At CFA-17/47 organic compounds were calculated using maximum concentrations.

b. Xylene was detected at 10 ft bgs.

* Metal concentrations (mg/kg) typically found in INEEL soil is discussed in Rood et al. 1996.

addressed in the WAG-level ERA by eliminating those that clearly pose a low likelihood for risk, (2) better defines the nature and extent of contamination at individual WAG sites, (3) indicates sites for which further data are needed, and (4) identifies other data gaps. The results of this assessment serve to support problem formulation and drive media and pathways to be evaluated for the WAG-level ERA. This pre-assessment methodology will be used to screen additional sites and/or contaminants identified during the ongoing CERCLA process. This level of the assessment does not support setting remedial action levels. Details of SLERA methodology can be found in VanHorn et al. (1995).

The second phase is the WAG ERA, which represents the baseline risk assessment of the No Action alternative for remediation. The WAG ERA incorporates the screening results to assess potential risks to ecological receptors at the WAG-level following EPA guidance (1992). The method parallels the human health risk assessment in that each site at the WAG is individually assessed. This section presents the WAG ERA for OU 4-13. Table 7-21 summarizes the ERA screening steps used at WAG 4 sites. The WAG ERA results will (1) provide a list of COPCs to be addressed in the OU 10-04 ERA, and, (2) identify OU 10-04 level data gaps that must be filled before performing the OU 10-04 ERA. The results of the WAG ERA may also support risk assessments to evaluate WAG remedial actions or additional assessments, if necessary.

The third phase of the ERA process is the OU 10-04 ERA, which is performed to evaluate risk to INEEL-wide ecological resources. The OU 10-04 ERA will integrate the results of the WAG ERAs for all INEEL WAGs to determine whether contamination at the WAGs contributes potential risk to populations and communities on an ecosystem-wide basis (i.e., over the entire INEEL).

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